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Global Community Technology Challenge (GCTC) Strategic Plan 2024-2026

Smart City Infrastructure Program

Initial Public Draft

Michael Dunaway
Thomas Roth
Edward Griffor
David Wollman

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C Y B E R - P H Y S I C A L S Y S T E M S

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Initial Public Draft

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IoT Devices and Infrastructures Group*

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32 **ABSTRACT**

33 This publication provides a Strategic Plan for the Smart City Infrastructure (SCI) program of the
34 Communications Technology Laboratory at the National Institute for Standards and Technology (NIST),
35 the research laboratory of the U.S. Department of Commerce. The SCI program manages the Global
36 Community Technology Challenge (GCTC), a nationwide public-private partnership of cities and
37 communities; local and state government agencies; and private-sector for-profit and non-profit entities. The
38 GCTC is dedicated to improving the urban, suburban, and rural ecosystems and residents' overall quality
39 of life through the integration of advanced cyber-physical systems and Internet of Things (IoT)-based
40 technologies. NIST serves as coordinator for this partnership in collaboration with other federal agencies
41 and offices that sponsor smart city-related projects and research activities. The convention "smart city," is
42 used generically throughout this document to represent any city, township, or community that develops,
43 invests in, and integrates digital technologies to improve city services for the benefit of the community and
44 its residents.

45 This strategy is based on a consensus planning process chartered by the NIST SCI program in collaboration
46 with the leadership of twelve GCTC technology sectors (i.e., working groups), who collectively represent
47 over 220 regions, cities and communities that have initiated smart city programs or projects as GCTC
48 member communities. This document aligns with the current Administration, Department of Commerce,
49 and NIST strategic documents, and covers a planning period of three years, from 2024-2026.

50 **Keywords**

51 Smart cities and communities; Cyber-physical systems; Internet of Things (IoT); Key Performance
52 Indicators (KPIs); Critical infrastructure; Smart city standards; Community resilience; Urban and city
53 planning; Mission critical communications.

54

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109

110 **Executive Summary**

111 This publication provides a Strategic Plan for the Smart City Infrastructure (SCI) program of the
112 Communications Technology Laboratory at the National Institute for Standards and Technology (NIST).
113 The SCI program coordinates research in smart city technologies and manages the Global Community
114 Technology Challenge (GCTC—formerly the Global City Teams Challenge) a public-private partnership
115 of smart cities created and maintained by NIST. This plan covers a 3-year period of research, development,
116 testing, and evaluation from 2024 to 2026 and has three principal objectives:

- 117 1) Establish a research-based, scientific foundation for the Smart City Infrastructure program and the
118 GCTC—in collaboration with NIST research programs and operating units—with emphasis on the
119 measurement of outcomes of technology integration within smart cities.
- 120 2) Broaden the definition of “smart cities” to include rural areas and smaller municipalities and
121 address current challenges of smart connected systems in order to enhance access and transparency,
122 build community integrity, and ensure equitable distribution of benefits to all community residents.
- 123 3) Continue advancing the GCTC as a national and international public-private partnership with
124 federal government sponsorship dedicated to the development, testing, and integration of advanced
125 technologies for the benefit of cities and communities.

126 Appendix A to this document summarizes a corresponding 3-year plan for the Global Community
127 Technology Challenge developed through a consensus planning process involving a team of community
128 and technology leaders of the GCTC program. The Appendix consolidates successes and lessons learned
129 by GCTC member communities, and experiences gained from analysis of the broader smart city landscape
130 and offers a community-focused perspective on this national public-private partnership in smart cities and
131 supports the federal (NIST) program described in Sections 1-4. The consensus strategy was developed
132 through a series of Strategic Planning Workshops held from 2022-2023 with the leadership of the GCTC
133 Technology Sectors, which collectively represent over 220 U.S. and international community-based Action
134 Clusters, organized into the following twelve technology sectors:

- 135 • Transportation infrastructure, autonomous systems, and vehicles
- 136 • Wireless communications and broadband applications and access
- 137 • Cybersecurity and privacy for both public and private sectors
- 138 • Data governance and city data platforms and dashboards
- 139 • Public utilities for energy, water, and waste management
- 140 • Public safety and security; mission-critical communications
- 141 • Community well-being; trust, integrity, diversity, and equity
- 142 • Community resilience, adaptability, and sustainability
- 143 • Agriculture and rural productivity and quality of life
- 144 • Smart building technologies and IoT applications
- 145 • Smart Regions and collaboration strategies
- 146 • Education and workforce development

147 The GCTC Strategic Plan is based on the concept that a “smart city”¹ is a community ecosystem in which
148 advanced technologies are adopted in order to increase the efficiency, availability, and accessibility of city
149 services with the goals of improving city operations, enhancing public safety and community resilience,
150 equitably distributing economic and social benefits, and improving overall quality of life for residents. The
151 principal goal of this program is to support the ability of any region, municipality, community, or
152 neighborhood in achieving its vision for public-focused innovation through the application of advanced
153 technologies.

154 This document and the strategy that it describes should be considered a “living document” and will be
155 updated as the plan, the IoT and CPS² technologies, and the smart cities movement evolve.

156

¹ The term “smart city” as used throughout this document is a widely accepted term to represent any city, community, town, or region that develops, invests in, and integrates digital technologies with the goal of improving services and operations, enhancing cost-effectivities, and improving resident’s quality of life (See Section 1.3). Where the term Smart City is capitalized in this document, it references the NIST Smart City Infrastructure program or other NIST initiatives or documentation. Where the term appears in lower case, it refers to smart cities, generically (e.g., the “broader smart city community”).

² Internet of Things (IoT) and Cyber-Physical Systems (CPS) are foundational technologies in smart cities and are described in this document.

157 **1. Introduction and Origin of the GCTC**

158 This publication provides a Strategic Plan for the Smart City Infrastructure program (SCI) of the
159 Communications Technology Laboratory at the National Institute for Standards and Technology (NIST).
160 The SCI program conducts research in smart cities and IoT-based technologies and coordinates the Global
161 Community Technology Challenge (GCTC—formerly the Global City Teams Challenge) a smart cities
162 program established and maintained by NIST.

163 The GCTC is an international public-private partnership of cities and communities, local and state
164 government agencies, private-sector for-profit and non-profit entities, universities, and research institutes
165 dedicated to improving urban, suburban, and rural environments and residents’ quality of life through the
166 integration of advanced cyber-physical systems and Internet of Things (IoT)-based technologies. NIST
167 serves as the federal coordinator for both the national and international dimensions of the partnership, in
168 collaboration with other federal agencies and offices that sponsor smart city-related projects and research.

169 The National Institute of Standards and Technology (NIST) is the research laboratory of the Department of
170 Commerce with the mission to promote U.S. innovation and industrial competitiveness by advancing
171 measurement science, standards, and technology in ways that enhance economic security and improve our
172 quality of life. Through the creation and sponsorship of the GCTC, NIST plays a significant role in
173 catalyzing the transition of advanced technologies and standards to states and local communities in order
174 for them to improve options for technology integration. The resulting integrations can allow communities
175 to improve city services, build resilient infrastructure, advance economic equity and sustainability, and
176 improve residents’ overall quality of life. NIST’s focus on creating critical measurement solutions and
177 promoting the development and adoption of consensus-based standards provides a unique contribution as
178 a federal agency partner to the global smart cities movement. Likewise, NIST’s development of
179 frameworks, measures of effectiveness, and analytic tools offers city officials, community leaders, and
180 citizens the ability to more effectively assess investment options and to make informed decisions about
181 benefits, costs, and achievements in advancing city goals and objectives through the integration of advanced
182 technologies. As explained in the NIST Strategic Plan 2020-2025,

183 NIST engages in technology transfer working directly with companies and
184 organizations locally and nationally to transfer technology developed in the NIST
185 labs. For NIST to accomplish its mission, our research results must reach the
186 private sector for implementation.” [1].³

187 The GCTC originated from a 2013 initiative of NIST and its Presidential Innovation Fellows, working in
188 partnership with the White House Office of Science and Technology Policy (OSTP) and other federal
189 agencies, called the “SmartAmerica Challenge,” which had the goal of accelerating the development and
190 integration of advanced technologies to address a wide array of challenges facing cities, both in the U.S.
191 and globally. The GCTC was formally established by NIST in 2013 as the Global City Teams Challenge
192 and held its inaugural workshop at NIST’s Gaithersburg campus in September 2014, with a call to city
193 teams, technologists, and researchers with experience in developing and integrating Cyber-Physical

³ Appendix C contains citations and references from current federal agency strategy documents relevant to smart systems, cities, and communities, which serve as many of the source documents for this strategic plan.

194 Systems and Internet of Things (IoT) technologies at the municipal and regional levels. The principal
195 challenge that the GCTC was established to address was articulated in a NIST Special Publication (1900-
196 01), issued in 2016:

197 “Hundreds of cities and dozens of technology providers are working to realize
198 civic benefits and potential profits across a broad range of services and markets.
199 However, the critical goal of interoperability is in danger of being overwhelmed
200 by the large wave of isolated and customized solutions, along with the
201 accompanying proliferation of proposed standards and protocols” [2].

202 Furthermore,

203 “... many current smart city ICT⁴ deployments are based on custom systems
204 that are not interoperable, portable across cities, extensible, or cost-effective.”
205 However, “if too many details are standardized, innovation is overly
206 constrained; if nothing is standardized, the result is non-interoperable clusters
207 of function that are not easily integrated.” [2].⁵

208 In response to these challenges, the GCTC adopted the following four goals for the program:

- 209 1) Stimulate the growth and assembly of a large and diverse set of smart city projects, and build a
210 broad community of organizations and individuals working in the smart city space.
- 211 2) Using this GCTC community of projects as an “at-scale testbed environment,” apply a variety of
212 analytical approaches to distill significant commonalities and identify quantifiable measures of
213 effectiveness and metrics for success.
- 214 3) Through an iterative process of conferences, expos, and networking, work with the GCTC
215 community to encourage the entire smart city community toward greater interoperability,
216 scalability, measurability, and replicability, define best practices, and encourage coherence.
- 217 4) Use insights from the GCTC ecosystem, with its expanding and diverse application space to inform
218 development of the NIST Cyber-Physical System testbed and research program.

219 The GCTC was built on a structure of community-focused “Action Clusters” from cities across the U.S.
220 and the globe. Action Clusters represented city teams, organizations, industries, and agencies “taking
221 action” on specific city challenges. The goal of the GCTC was to spur collaboration among innovative local
222 governments and agencies, nonprofits, private companies, and university research centers to overcome
223 challenges and develop solutions with leaders in the smart city and IoT fields. Through participation in the
224 GCTC, companies, universities, and nonprofits showcased their technologies to potential customers and
225 partners and collaborated with local government leaders and technology developers to deploy
226 interconnected solutions. The program goals identified in the original NIST 2016 report had by 2019
227 achieved a significant benefit for the GCTC member communities, as well as for the larger national and

⁴ Information and Communication Technologies

⁵ A history of the GCTC is outlined in two NIST Special Publications, 1900-01 (2016) cited above, and NIST Special Publication 1900-204 published in 2019. Citations and links are in the Reference section of this document.

228 international smart city and stakeholder communities. Figure 1 provides the 2022 depiction of the extent of
229 GCTC member communities.



230

231

Figure 1. GCTC U.S. membership and global partners 2016-2022.

232 Since its launch at the 2014 NIST workshop, the GCTC program had by 2022 evolved into a network of
233 over 220 U.S. and international cities and communities, involving over 500 industry, academic, and
234 government stakeholders who jointly develop and deploy advanced technologies for smart cities and
235 communities. The program has created an ecosystem for information sharing in which communities can
236 gain tangible benefits from collaboration and exchange of best practices to improve efficiency, lower costs
237 through economies of scale, and improve the lives and economic benefits to their populations.

238 In October 2016, the GCTC organized its 160 existing Action Clusters into a set of “SuperClusters” based
239 on specific community services, infrastructure sectors, and mission areas. The SuperClusters have since
240 evolved as the organizing structure for the GCTC, representing specific technology sectors or focus areas,
241 while also coordinating the activities of a diverse set of community Action Clusters from cities and regions
242 across the nation and among international partners. By 2019, the initial seven SuperClusters had expanded
243 to nine, and in 2020 two more were added to comprise eleven technology sectors and working groups. In
244 early 2022 a twelfth Supercluster was initiated, with a focus on trust, integrity, diversity and equity. The
245 current organizational structure for the GCTC includes the 12 Technology Sectors illustrated in Figure 2.



246

247

Figure 2. GCTC Technology Sectors

248 Many of the SuperClusters have since published a blueprint or guidebook for communities to use in
249 establishing a smart city project or program in a specific technology or service sector. All blueprints are
250 accessible from the main GCTC website [2]. Figure 2 depicts the organizational structure, now designated
251 simply as the GCTC Technology Sectors.

252 1.1. Purpose of a Strategic Plan for GCTC

253 With the successful establishment of the GCTC community in 2014 and implementation since 2016 of the
254 organizing structure provided by the Technology Sectors, there is now a need for a common, integrated
255 strategy to guide the GCTC program, and to provide a unified approach to smart city research, development,
256 test, and evaluation (RDT&E) within the GCTC and the NIST Smart City Infrastructure program. There
257 are also significant benefits to be gained for the larger smart city community—within the U.S. and among
258 international partners—by the establishment of an integrated strategy for enabling cities to measure and
259 assess smart city investments through a sponsoring agency at NIST under the Department of Commerce.

260 The development of an integrated approach to smart city initiatives will likewise support the NIST mission
261 to initiate standards development, enhance measurement science, and assist in developing common
262 architectures and key performance indicators (KPIs) for the integration of IoT-based sensors, cyber-
263 physical systems, and communications technologies in smart cities and communities. The active leadership
264 and engagement of NIST in support of local officials, agencies, industries, and citizens through the GCTC
265 program represents a significant step toward ensuring that federal research investment and outcomes have
266 an impact in local communities, and tangible benefits for their residents.

267 Of equal importance is the growth and transformation of the GCTC program in light of the continuing
268 maturity and more widespread acceptance of smart city technologies and initiatives. The adoption of such
269 technologies as broadband communications, artificial intelligence, autonomous vehicles, data mining, and
270 networked sensors has transcended both the state of the art and the extent of dispersion of advanced
271 technologies that existed at the time the GCTC program was launched. Likewise, there now exist a number
272 of non-profit and research institute-based smart city programs, which contribute to the broader smart cities
273 community through their own unique identities, regional perspectives, and partner bases, and sponsorship
274 of national and international conferences. Based on its relationship to the NIST Smart Connected Systems
275 Division, the GCTC can support the common interests of those organizations through outreach and
276 collaboration, participation in public workshops and conferences, and sharing of best practices to the mutual
277 benefit of cities, communities, regions, and organizations.

278 Finally, the significant changes in the natural, social, and virtual environments within the last several
279 years—to include significant threats to the urban environment such as climate change, extreme weather and
280 natural disasters; threats to cybersecurity, trust, and privacy for organizations and individuals; and the most
281 recent threat posed by a global pandemic and its widespread social, political and economic impacts—argue
282 for a reassessment of current and future priorities for the GCTC and the larger smart city community.

283 In recognition of the foregoing successes and challenges, this Strategic Plan initiates a redesignation and
284 rebranding of the GCTC as the **Global Community Technology Challenge**. This change in program name
285 recognizes the global nature of current challenges to the urban environment and the range of the adoption
286 of smart technologies among cities and communities, both in the U.S. and internationally. This Strategic
287 Plan for the GCTC is intended to address these and other considerations and initiates a 3-year program of
288 research and development, evaluation, and implementation of smart city concepts, technologies, and
289 standards in collaboration with GCTC member communities, private sector organizations, government
290 agencies at the federal, state, and local levels, and international partners with similar smart city and
291 community initiatives and goals. The key objective of this strategy is to establish extensible, standardized
292 technologies and processes for measuring effects and outcomes as the foundation for the continued
293 advancement of the GCTC and the expanding smart cities community in support of the NIST and
294 Department of Commerce missions, as described in a recent White House Budget Memorandum:

295 “Agencies should collaborate to promote world-leading research and innovation
296 boosting American industries and quality American jobs in emerging
297 technologies ... and actively pursue public-private partnerships that will
298 expedite American leadership in technologies to grow our inclusive 21st
299 Century digital economy.” (EOP FY 2023 Budget Memorandum M021-32, p.
300 3). [3].

301 **1.2. Audience for the GCTC Strategic Plan**

302 This document is intended to serve three primary audiences:

- 303 1) First and foremost, it provides background and future direction of the NIST GCTC and Smart City
304 Infrastructure (SCI) program to inform NIST leadership and research staff in the Communications
305 Technology Laboratory and other NIST Operating Units and assist in identifying opportunities
306 where NIST research efforts that can contribute to the development of smart city technologies.

- 307 2) Secondly, this document provides guidance to the GCTC leadership in defining programmatic
308 priorities and direction from the perspective of the federal sponsoring agency (i.e., NIST) while
309 serving as a guide for development of the community-focused strategy provided in Appendix A.
- 310 3) Finally, the GCTC Strategic Plan will provide guidance in defining priorities for GCTC community
311 and regional programs and assist in building a common approach to smart city initiatives, while
312 establishing a reference point for future planning within the GCTC. The document will also inform
313 GCTC member communities of opportunities for collaboration with NIST research staff in
314 evaluating advanced smart city technologies for their communities.

315 1.3. Concept and Definition of a Smart City

316 This GCTC Strategic Plan is based on the concept that a “smart city” is a community ecosystem in which
317 advanced digital technologies are adopted in order to increase the efficiency, availability, and accessibility
318 of city services with the goals of improving efficiency in city operations, enhancing public safety and
319 community resilience, equitably distributing economic and social benefits, and improving overall quality
320 of life for residents. In this document, where phrases such as “smart city,” “urban ecosystem,” “urban
321 environment,” and “smart systems” are used there is no inherent criteria of size, population, geography, or
322 typology that constrains or limits considerations as a “smart city.” A principal goal of this program is to
323 support the ability of any community, municipality, or region to achieve its vision for public-focused
324 innovation through the application of advanced technologies. This definition is equally applicable to rural
325 towns, communities and agricultural regions having more dispersed populations that would benefit from
326 digital communications and connectedness. For purposes of this strategy, a smart city (community, town,
327 region, etc.), will be considered one that puts priority on, and engages in activities (including research and
328 development) that enable the:

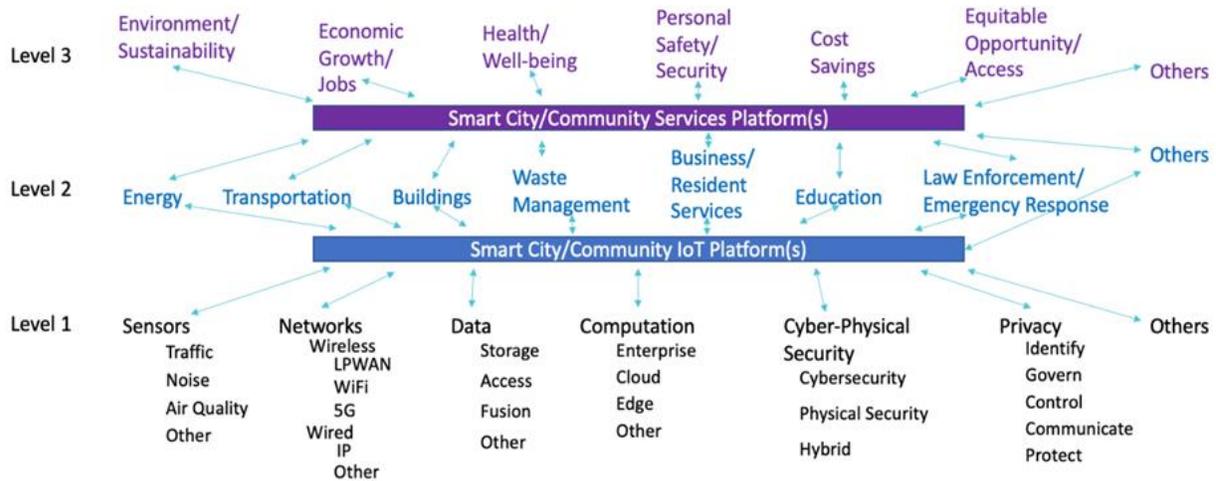
329 **“Efficient use of digital technologies to provide prioritized services and**
330 **benefits to their community.” [4]**

331 Ultimately, these technologies and the outcomes of their adoption can be analyzed and potentially
332 quantified along a number of vectors to include:

- 333 1) Number of digital services and benefits
334 2) Efficiency in implementation, and reuse or dual-use
335 3) Quality of services and benefits delivered
336 4) Alignment with community priorities

337 A principal goal of this strategy and the GCTC program will be to consider the smart city in a holistic and
338 comprehensive manner, aligning projects at the community, municipal and regional levels to consider the
339 inter-relationships among the social, built, and natural environments, as well as between critical
340 infrastructure sectors, cyber-physical systems, and IoT-based technology applications. In 2022, NIST
341 issued its Special Publication 1900-206, “Smart Cities and Communities: A Key Performance Indicators
342 Framework,” that provides a depiction of the relationships between technologies and data systems, service
343 platforms, and community outcomes within a representative smart city [4]. Figures 3 below is excerpted

344 from that publication and illustrates the network of relationships between technologies, platforms, and
 345 outcomes as an approach to understanding the smart city holistically as a networked system of systems.



346
 347 Figure 3. System levels and relationships of smart city platforms, services, and outcomes [4]

348 As explained in the NIST Key Performance Indicators Framework, the *holistic relationships* among
 349 elements of a smart city or community may be represented as a series of discrete steps in a data or
 350 information flow or pathway. Each step consists of a source, path, and destination, representing sensors,
 351 platforms, data stores, applications, etc. that are the origin for the data or information transmitted along a
 352 specified path. The path represents the means for transmission and may include wired or wireless networks
 353 or other transmission methods. The destination is the application, platform, data store, etc. receiving the
 354 transmitted data or information. Figure 3 depicts the smart city structure at three interacting levels of
 355 analysis—technologies, infrastructure services, and community benefits—based on the community network
 356 of sensors, data, and systems.

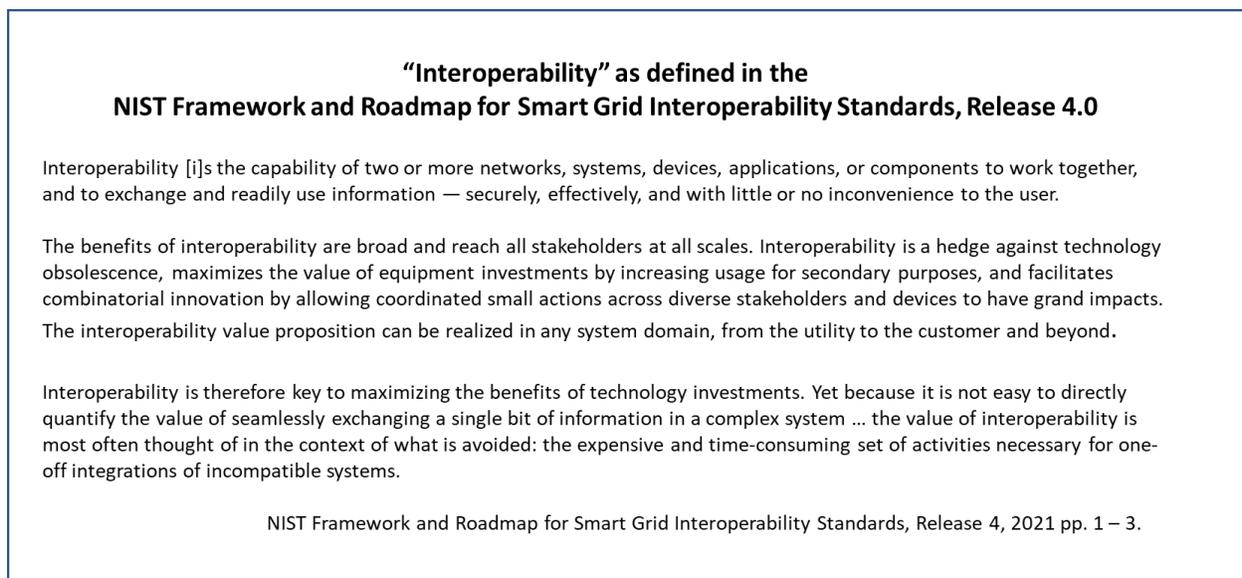
357 In Figure 3, Level 1 focuses on enabling technologies and their core capabilities. Examples of technologies
 358 include sensors and actuators, networks and connectivity, data systems, and computational hardware and
 359 software systems. Examples of core characteristics are the elements of trustworthiness – security, privacy,
 360 resilience, reliability, and safety. Data analytics at this level focus on non-biased data, technology, and
 361 service metrics such as network capacity, sensor accuracy and coverage, system downtime and recovery,
 362 conformance with security and privacy guidance, etc.

363 Level 2 describes the infrastructure services and operations that enable a city or community to function.
 364 Infrastructures include those in the communications, transportation, energy, water, and buildings sectors,
 365 which range from roads and bridges to networks, pipelines, electric grids, and commercial and residential
 366 structures. Key services include emergency response and law enforcement, waste management, education,
 367 and city/community services. Data analytics at this level are centered on measures of infrastructure
 368 functions, such as broadband access and public transit use, and on service effectiveness, such as emergency
 369 response time and access to education.

370 Level 3 illustrates the benefits that community residents, businesses, and organizations can attain through
 371 the equitable access to technology adoption as determined through the analysis of Key Performance

372 Indicators to achieve a holistic integration of the city’s infrastructure. Examples include personal safety and
373 security, business and job growth, health care, environmental quality, and other quality of life factors
374 including culture, arts, and entertainment. Data and analytics at this level focus on the experiences of
375 residents, visitors, and businesses throughout the city or community.

376 A key consideration for any smart city development or deployment is the role of **interoperability** in
377 ensuring that technologies integrated into city infrastructure and operations are fully compatible with
378 existing or legacy systems, and will also accommodate future improvements and new applications to be
379 incorporated. For this reason, interoperability may be considered a fundamental requirement for any smart
380 city project or program. As a foundation of both the SCI and GCTC programs, this strategic document
381 adopts the definition and concept of interoperability provided in NIST Special Publication (1108r4), NIST
382 Framework and Roadmap for Smart Grid Interoperability Standards, Release 4, described in Figure 4 [5].



383

384 Figure 4. NIST definition of “Interoperability” as a foundation of smart city development [5]

385 With these definitions and the representations of community platforms, infrastructure, and levels of analysis
386 in mind, this strategy will endeavor to enable development of both conceptual and technical foundations
387 for analyzing smart cities and communities as networks of systems within a geographic region that are
388 purposefully designed to enhance the security, economic vitality, and quality of life among the residents.

389 2. Strategy for the Next Phase of the NIST GCTC

390 The smart city may be considered as an evolution of advanced digital technologies employed to provide
391 services for the benefit of society, standing at the intersection (in both time and geography) of complex
392 challenges that arise from current local, regional, national, and global trends. In such an environment, the
393 transformation of a city or community will be dependent on the community’s investment in digital
394 technologies and the alignment of those technologies with the economic, social, cultural, and environmental
395 goals that the community has established for itself.

396 In the initial years of the GCTC (and the broader smart cities movement, as well) the principal focus was
397 on developing and integrating technology applications that would address the urgent challenges cities faced
398 in developing, managing, and improving critical infrastructures, solving seemingly intractable challenges
399 such as vehicle traffic management, the resilience and operation of public utilities during disasters, and
400 improving communications with residents via information technologies and city dashboards. Later, the key
401 challenges and many of the technology applications were directed at understanding the city’s or
402 community’s built environment and its relationship to the natural environment. Much of the energy and
403 resources invested was in developing methods and technologies to enhance understanding—that is,
404 situational awareness—of the relationships occurring across critical information sectors, and between the
405 built infrastructure and the natural environment, particularly those dedicated to enhancing decision-making
406 through the integration of data systems. Over the past several years, however, there has been an evolution
407 of thinking across the smart cities community toward a more holistic understanding of what actually
408 constitutes “smartness” in a city or community. This trend has, in effect, redirected the focus of digital
409 transformation away from technology development and integration, per se, and towards the objectives or
410 goals that the community has established for itself, with technology adoption and digital transformation as
411 a means to those ends. Figure 5 is a simplified depiction of the evolution of the GCTC (and the broader
412 smart city community) areas of focus over the last decade.



413 2014 —————> 2023

414 Figure 5. Evolution of the smart city concept and dimensions

415 More recently, as cities and communities have become more connected, networked and technologically
416 sophisticated, new challenges and opportunities have arisen that demand a rethinking of traditional
417 approaches to sustainability, resilience, public safety and social services, information and communications,
418 and the human relationship to technology. The design and integration of intelligent infrastructure—
419 including embedded sensors, the Internet of Things (IoT), advanced wireless information technologies,
420 real-time data capture and analysis, and AI-based decision support—hold the potential to greatly enhance
421 economies, social interaction, public safety and security, and overall community resilience, while
422 addressing new and emerging challenges in urban society. At the same time, however, the trajectory toward
423 universal connectedness, pervasive computing, and technological integration at all levels of society has
424 challenged many of our traditional notions of what it means to live in an open society with high quality of
425 life. This highlights the tensions between a number of social and technological priorities:

- 426 • Safety and Security vs. Openness and Convenience
- 427 • System Complexity vs. System Reliability

- 428 • Community Security vs. Individual Privacy
- 429 • Artificial Intelligence vs. Human Autonomy
- 430 • Universal Accessibility vs. Transparency and Trustworthiness

431 As a consideration of these and other challenges, the smart city is now widely understood to include the
432 need to address challenges in the social, economic, and cultural dimensions of the urban environment, as
433 well as the integration of technology into human society and individual lives. The objective is to employ
434 advanced technologies to mitigate the inherent tensions that exist in seemingly competing community
435 priorities exemplified by those listed above. The ultimate goal is to approach smart city design from a more
436 holistic perspective and achieve an integration of systems and relationships between the human population
437 and the built and natural environments.

438 This strategic plan and the next phase of the GCTC will therefore include considerations of the broad
439 spectrum of technological, environmental, social, and human dimensions of the urban and rural ecosystem
440 and will put emphasis on how those factors—including intangible factors such as community well-being,
441 social connectedness, diversity and cohesion, and community resilience and integrity—should be
442 understood, measured, and prioritized as both characteristics and determinants of the smart community.

443 **2.1. GCTC Vision and Mission**

444 To date, there are few formal organizations or opportunities that exist for collaboration between technology
445 researchers and developers, public agencies and professionals, and local government officials and
446 community leaders where capability gaps and priorities for community development can be discussed and
447 potential technology solutions identified and tested. Moreover, the trend toward IoT sensors and cyber-
448 physical systems—coupled with dramatic changes in hazards and threats to complex, urban societies—
449 argues for an organization and framework for identifying innovative technologies, strategies, and
450 capabilities within a fully collaborative, multi-disciplinary environment.

451 To that end, the goal of the GCTC is to establish an enduring, international public-private partnership to
452 build capacity in research and development in technologies for public benefit through engagement with a
453 coalition of community officials and leaders, private sector developers, university researchers, community
454 stakeholders, and government agencies at all levels. This partnership will examine and facilitate the
455 adoption of innovative concepts that enhance the delivery of public services in such areas as public safety,
456 health, and security; economic vitality and equity; community resilience and sustainability; and challenges
457 at the interface between urban and rural ecosystems. The initiative has four objectives:

- 458 1) Support the smart city movement by nurturing integrated, multi-disciplinary research in strategies
459 and technologies across technical, jurisdictional, and geographic boundaries;
- 460 2) Identify and address capability gaps and challenges and assist in developing frameworks, analytic
461 methods, and resources to build a scientific foundation for smart cities and communities;
- 462 3) Facilitate collaboration with federal, state, county, and municipal partners to define and validate
463 technology requirements, metrics, and standards for enhancing community services and operations;
- 464 4) Sponsor opportunities for enhancing programs in Science, Technology, Engineering, Art, and Math
465 (STEAM) and other interdisciplinary educational programs to engage the next generation of

466 scientists, engineers, technologists, community leaders, and citizens while contributing to local and
467 regional workforce development goals.

468 As in the previous years, the immediate goal of the GCTC is to provide a forum for increasing awareness
469 of emerging technology applications and enhancing collaboration among GCTC member communities and
470 smart city partners. Future efforts will be dedicated to enhancing research and information sharing and to
471 advance state-of-the-art, technologies and concepts. The Vision and Mission Statements to guide the GCTC
472 are as follows:

473 **VISION:** Sustain a federally sponsored collaboration among communities
474 dedicated to improving city services and enhancing quality of life through the
475 integration of advanced technologies.

476 **MISSION:** GCTC will coordinate a public-private partnership of communities
477 dedicated to accelerating the integration of advanced technologies to achieve
478 digital transformation and enable communities to become more sustainable,
479 equitable, resilient, and livable.

480 As the GCTC sponsoring organization, the NIST Smart Cities Infrastructure program will identify research
481 opportunities and develop methods for assessing options, measuring outcomes, and developing standards
482 and key performance indicators to assist city officials, community leaders, and citizens in assessing benefits,
483 defining costs, and achieving community goals from the adoption of advanced digital technologies.

484 **3. Principal Goals of the GCTC 2024-2026**

485 A principal objective of the NIST Smart City Infrastructure (SCI) effort is to build collaborative research
486 partnerships between NIST laboratories and Operating Units with the advanced technology initiatives of
487 U.S. cities, industry partners, and university research laboratories. Through the Global Community
488 Technology Challenge, the SCI research program leverages smart cities and communities in partnership
489 with NIST expertise in measurement science and standards development to build a network of community-
490 focused “living laboratories” to define a science-based understanding of how cities function as complex
491 adaptive systems having technological, environmental, economic, and social dimensions. Research into
492 current and future challenges in smart cities and communities will necessarily involve multi-dimensional
493 problems in IoT modeling and simulation, interoperability, automation and autonomy, and data analytics
494 that will bridge diverse domains and stakeholders.

495 This section highlights three defining goals under the GCTC Strategic Plan and orients the GCTC toward
496 specific accomplishments at the program level with community and city partners. In several cases,
497 achieving these goals will be contingent on dedicated funding, either through NIST program funds, or
498 though partnership with other funding agencies or community and corporate partners.

499 **3.1. Goal 1: Establish a research-based, scientific foundation for the NIST Smart Cities** 500 **Infrastructure program, the GCTC, and the broader smart cities community.**

501 This goal will focus on aligning the Smart City Infrastructure program and GCTC public-private partnership
502 with the work of the NIST laboratories and Operating Units with the goal of leveraging NIST research that

503 would advance smart technologies to benefit communities. GCTC will target both internal (NIST) and
504 external (other federal agency) outreach to expand the research base and empirical foundations of the Smart
505 City Infrastructure program and will form a Smart City Community of Interest across NIST. A related goal
506 is to develop a catalog of research projects and organization contacts engaged in projects that are directly
507 or indirectly related to GCTC and smart cities initiatives. This effort will include the following:

- 508 • Develop a repository and library of GCTC and smart city sources, resources, apps, courses, etc.
509 and make it available to GCTC, the smart city community, and the general public.
- 510 • Define a program of research on standards and key performance indicators for smart cities, in
511 collaboration with GCTC communities and Standards Development Organizations (SDOs).
- 512 • Initiate Pilot Tests of H-KPI implementation in select GCTC smart cities with a focus on public
513 safety, mission-critical communications, community resilience, and sustainability.

514 **3.2. Goal 2: Broaden the scope and agenda for smart cities to address current**
515 **challenges and achieve the equitable distribution of outcomes for community**
516 **residents, businesses, and organizations.**

517 A priority research area within the GCTC is directed at understanding the nexus between the adoption of
518 digital technologies and the enhancement of social and economic benefits accruing from the community’s
519 investment in those technologies. The term adopted in the GCTC for the ultimate goal of the smart city is
520 “Integrity” (depicted in Figure 5) as both an engineering concept (i.e., systems or design integrity) and as
521 an ethical or moral construct reflecting the public’s trust in technologies, data, and decision systems, as
522 well as in the community’s decision-makers, leadership, and relationships. The “smart city” is now widely
523 understood as a balance among technical, environmental, socio-economic, and cultural dimensions of the
524 urban environment, and not simply the adoption of advanced technologies to increase efficiencies and cost-
525 effectiveness. To that end, the GCTC program is initiating a focused research effort on defining the
526 characteristics of trust, integrity, diversity, and equity as a foundation of the smart city that yields
527 measurable outcomes in quality of life and overall community well-being.

528 The GCTC Trust, Integrity, Diversity, and Equity (TIDE) project focuses on identifying KPIs to assess the
529 intersections of smart city technologies and applications with the outcomes sought to build community
530 integrity at both the system and societal levels. The TIDE concept as applied within the GCTC program is
531 not directed solely at measuring social and economic outcomes, but rather at defining a broad metric for
532 understanding the holistic relationship between the integration of advanced technologies with the goals of
533 the community. In this regard, “diversity” is more aligned with the broad definition established by the
534 International Telecommunications Union (ITU) Study Group on Internet of Things (IoT) and Smart Cities
535 and Communities (SC&C) [6], which characterizes diversity from five perspectives:

- 536 • Diversity of services and applications.
- 537 • Diversity of data and data sources.
- 538 • Diversity of devices, networks, and transmission methods.

- 539 • Diversity of sensing modes and sensor systems.
- 540 • Diversity of management and governance modes.

541

542 This effort will focus on the identification of key performance indicators and factors contributing to the
543 enhancement of Trust, Integrity, Diversity, and Equity (TIDE), and will initiate several multi-disciplinary
544 research focus areas across GCTC member communities to include:

- 545 • Incorporation of “Trust, Integrity, Diversity, and Equity (TIDE) as a cross-cutting foundation of
546 the GCTC and smart cities in a manner similar to the cross-cutting priority given to cybersecurity
547 and privacy considerations across all sectors and infrastructures of smart cities.
- 548 • Expand GCTC partnerships to include smaller cities, underserved communities, urban “technology
549 deserts,” and constituencies who have not been engaged in GCTC and smart city efforts. A specific
550 focal point of this effort is to include Native American and Tribal regions and communities.
- 551 • In consideration of current hazards and risks to communities, development of a risk management
552 framework for public safety, health, and resilience in smart cities to enhance public safety planning
553 and communications to achieve “whole community” disaster preparedness, response, and recovery.

554 The long-range goal of this effort is to develop a methodology for measuring (directly or indirectly) the
555 impact of technology programs within a city or community toward improving community integrity,
556 economic vitality, and overall quality of life and societal well-being and ensure the equitable distribution
557 of benefits across the diverse communities that typify a complex, modern city.

558 **3.3. Goal 3: Enhance the national public-private partnership of smart city programs,**
559 **research institutions, private sector enterprises, and the Next Generation of**
560 **community leaders, scientists and researchers.**

561 This is the principal public-facing goal of the GCTC and continues the collaboration strategy and
562 community outreach that has been the core and hallmark of the program since its launch in 2014. A major
563 change in direction is the intention to pursue more targeted themes in GCTC conferences and workshops
564 and expand the type, size, and description of communities engaged in GCTC, both domestically and
565 internationally. Priority program initiatives for this area include:

- 566 • Increase GCTC outreach and engagement with private sector business and industry and assist in
567 building collaborations with smart cities and communities. To this end, GCTC will collaborate with
568 the Baldrige Excellence Program [7] to develop a framework for smart cities to guide communities
569 in the design, integration, and evolution of smart systems in urban and rural environments.
- 570 • In partnership with ITA, IDC, DoS, and relevant U.S. foreign offices, build collaborations with
571 allied smart city programs and coordinate joint planning for international smart cities events.
- 572 • Engage students and support outreach programs and technology competitions at high school,
573 community college, and university levels, engage the next generation of researchers, technology
574 developers, and entrepreneurs and build long-term continuity in the national smart cities movement.

575 **4. Project Priorities for Smart City Infrastructure and GCTC Programs**

576 A key objective of the SCI program is to build partnerships between GCTC member communities, research
577 centers, and researchers of the operating units and research laboratories of NIST, particularly in the fields
578 of data analytics, autonomous systems, public safety communications, resilient infrastructure, energy
579 systems, and other multi-disciplinary research areas relevant to smart cities. In support of NIST research
580 priorities, GCTC member cities are positioned to serve as “living laboratories” and testbeds to assess the
581 impact of research into the integration of IoT systems and communication technologies in real-world
582 applications. Participation of NIST researchers with projects relevant to smart cities will advance
583 development and adoption of IoT applications and smart city standards and provide NIST with direct access
584 to end-user communities for fielding advanced technologies within complex, multi-dimensional
585 environments. For the 2024-2026 period, the following research efforts are of priority interest.

586 **4.1. Research and identify Holistic Key Performance Indicators (H-KPIs) for smart cities**

587 In February 2022, NIST published a document in the CPS Framework Series that introduced the concept
588 of Holistic Key Performance Indicators (H-KPIs). The document, “Smart Cities and Communities: A Key
589 Performance Indicators Framework” (NIST SP 1900-206, described in section 1.3 above), has received
590 significant attention from smart cities stakeholders. This effort will develop a new area of measurement
591 science based on implementation of H-KPIs to analyze smart city technology networks and quantify
592 efficiencies in the delivery of city services, improvements in infrastructure resilience, and enhancement to
593 residents’ overall quality of life. The H-KPI implementation will enable quantitative measurement and
594 assessment of smart city systems, infrastructure, and communications networks, and add an empirical
595 foundation to smart city technology adoption that is scalable to any size city or community.

596 As a priority endeavor, the project will conduct an initial workshop in 2024 in collaboration with the NIST
597 Public Safety Communications Research (PSCR) program to identify KPIs and develop a conceptual
598 framework for community coordination of preparedness, response and recovery from civil emergencies and
599 engage the civil population in a “whole community approach” to public safety and disaster response in
600 smart cities.

601 Subsequent efforts in 2025-2026 will develop a preliminary model of KPIs in critical infrastructure systems
602 that share common characteristics and are thus applicable and scalable to all communities. The goal is to
603 define the factors that would enable development of a holistic model of city or community digital
604 infrastructure (i.e., H-KPIs) and expand the knowledge of city systems and intersections that either present
605 vulnerabilities to be protected, or opportunities to enhance public safety, community resilience, and
606 environmental sustainability. Finally, the project will identify potential pilot cities/communities for H-KPI
607 demonstration based on data availability and shared stakeholder interest across a spectrum of city sizes and
608 demographic, geophysical, social, and economic dimensions.

609 **4.2. Build a GCTC Open Knowledge Network and Best Practices Repository (GCTC- 610 OKN)**

611 The Global Community Technology Challenge (GCTC) is a NIST-led public-private partnership
612 representing over 220 U.S. and international cities that have collaborated since 2014 on developing an
613 information sharing network as the foundation of the smart city research and development activities. GCTC

614 member cities constitute a de facto Open Knowledge Network of smart cities and communities with the
615 common goal of information sharing of data, technology solutions, best practices, and experience in the
616 development and integration of IoT technologies. However, to date, there is no consolidated repository on
617 smart city topics or research efforts that are available to the public. The lack of a central repository or library
618 of smart cities resources is a significant deficit for smart cities and sponsoring agencies and organizations.

619 As a priority, this effort will catalog current NIST documents, frameworks, and publications that can inform
620 GCTC and smart cities projects and begin building a library of documentation, best practices, lessons
621 learned, and resources from any smart cities program or sponsoring organization. This research activity will
622 lay the foundation for an open knowledge network (OKN) via a Wiki-based information sharing platform
623 to catalog and archive relevant smart city documents, NIST publications, lessons learned, and activities
624 between the GCTC communities and technology developers, industry partners, and university-based and
625 national laboratories engaged in smart city initiatives. The GCTC OKN is in prototype form on a publicly
626 accessible site (<https://OpenCommons.org>) and contains links to smart cities activities, GCTC newsletters,
627 the NIST GCTC pages, and other resources. In succeeding years, the GCTC OKN Wiki will be enhanced
628 to support collaboration opportunities among member communities on research gaps and needs, smart city
629 data, information, frameworks, and standards. The long-term goal is to serve as a repository for smart city
630 knowledge and best practices from GCTC communities, partnering organizations, and the broader smart
631 city ecosystem on a wiki-based site that can be accessed and edited by registered GCTC members.

632 **4.3. Collaborate with Baldrige Excellence Framework for Smart Cities and** 633 **Communities**

634 In collaboration with the NIST Baldrige Excellence Program [7], the SCI and GCTC programs will begin
635 development of a Framework for Smart City Excellence based on a Capability Maturity Model to guide
636 communities in the design, integration, and evolution of smart systems in urban—and rural—environments.
637 This effort will build on the previous years' efforts to develop and publish blueprints or frameworks for
638 individual GCTC Technology Sectors, and aims to develop a standard, integrated methodology or strategy
639 that communities can adopt for establishing goals and priorities, identifying opportunities, and planning
640 smart city enhancements, regardless of community size, description, geography, demography, or economy.
641 The effort will adopt the key focus areas from the current Baldrige Excellence Framework, with
642 modifications to target application to smart cities and communities:

- 643 • Digital transformation and economic sustainability
- 644 • Organizational and infrastructure resilience
- 645 • Innovation and workforce development
- 646 • Trust, Integrity, Diversity, and Equity.

647 In addition, given the centrality of cyber-physical systems and IoT-based infrastructure to smart cities, this
648 effort will adopt the principles of the Baldrige Cybersecurity Excellence Builder and the NIST
649 Cybersecurity Framework 2.0 [8] to further assist communities in enhancing the security of their critical
650 infrastructure systems, data, and communications, while protecting the privacy and welfare of their citizens.
651 Modeled on the approach implicit in the NIST Cybersecurity Framework, this initiative will adopt the
652 methodology of a Capability Maturity Model to enable communities to define and achieve progressive

653 levels of success and security in the digital transformation of their communities. This project will engage a
654 partnership of GCTC member communities, private sector and industry experts, and citizens' groups in
655 developing the Framework for Smart City Excellence over the next three years.

656 **4.4. Develop a Framework for Standards for Smart Cities and Communities and** 657 **participate in international Standards Development Organizations (SDOs)**

658 In 2023, the White House issued the United States Government National Standards Strategy for Critical
659 and Emerging Technology (NSSCET) with the objective of increasing private and public sector engagement
660 with Standards Development Organizations (SDOs) to “foster U.S. and likeminded nations’
661 competitiveness in emerging markets and work to vigorously promote our shared values and market
662 economies based on impartial and effective standards” [9]. The NIST NSSCET Working Group and
663 Standards Coordination Office lead development of an implementation strategy for the NSSCET and
664 throughout 2024 will be conducting outreach to the business sector, industry, technology developers and
665 U.S. SDOs to define appropriate standards for critical and emerging technologies.

666 Smart cities are cited in the NSSCET as among the specific applications of critical and emerging
667 technologies that “impact our global economy and national security.” The Smart Cities Infrastructure
668 program will be supporting NIST and the SCO in defining the approach to standards development and
669 implementation that is appropriate to the smart cities movement, which—like the U.S. standards process
670 itself—is based on voluntary, collaborative and open development that respects individual community
671 priorities, resources, and jurisdictions. As a function of the NSSCET discovery process, the Smart City
672 Infrastructure program will host a workshop of GCTC member communities to define an approach to smart
673 city standards and develop a Framework for Standards for Smart Cities and Communities that reflects U.S.
674 principles and goals.

675 In addition to facilitating opportunities for collaborations with U.S. smart cities, industry partners, and other
676 stakeholders, the NIST SCI and GCTC programs engage with selected international Standards
677 Development Organizations involved in smart city research and development efforts. Experience gained
678 through GCTC activities and interactions with U.S. communities informs NIST participation in standards
679 development efforts for U.S. smart cities and systems, while engagement with international SDOs provides
680 context for U.S. smart cities participation in international SDOs. Collaborating SDOs include the U.S.
681 Technical Advisory Group (TAG) of the IEC Systems Committee for Smart Cities [10], ISO/IEC Joint
682 Working Group 14 on Smart Cities Reference Architecture, and the Focus Group on Smart Sustainable
683 Cities of the International Telecommunications Union (ITU). Collaboration includes interaction with other
684 U.S. federal agencies with membership on the TAG that engage with international partners and SDOs in
685 international collaborations and cooperative agreements related to smart cities and technologies.

686 **4.5. Provide Technical Guidance to GCTC Member Communities and Partners**

687 The NIST SCI program continues to provide technical support and guidance to activities of the Global
688 Community Technology Challenge and the national public-private partnership for smart city and
689 community development. A priority of the GCTC effort is to build partnerships between the GCTC member
690 communities and research centers, researchers, and operating units of NIST, particularly in the fields of
691 data analytics, autonomous systems, public safety communications, resilient infrastructure, energy

692 sustainability, and other areas that require multi-disciplinary approaches to solving challenges in complex,
693 integrated smart city systems. This effort will support at least one NIST-sponsored workshop or conference
694 annually and maintain GCTC participation in other national and international smart city events.

695 This project also sponsors quarterly workshops scheduled and conducted by GCTC Technology Sectors to
696 maintain regional and community outreach between NIST and member communities, cities, and regions.
697 Workshops on technical aspects of smart cities and IoT/CPS integration serve to build the smart cities
698 research network and strengthens the relationship between the NIST GCTC program and participating
699 “living laboratory” communities. These workshops further serve to identify opportunities for collaboration
700 between research universities and technology developers, federal laboratories and research facilities,
701 including NIST.

702

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734

735 **List of Symbols, Abbreviations, and Acronyms**

736	AI	Artificial Intelligence
737	AR/VR	Augmented Reality / Virtual Reality
738	CISA	Cybersecurity and Information Security Agency
739	CPS	Cyber-Physical System
740	CTL	Communications Technology Laboratory
741	DEI&T	Diversity, Equity, Integrity, and Trust
742	DHS	Department of Homeland Security
743	DOS	Department of State
744	EOP	Executive Office of the President
745	GCTC	Global Community Technology Challenge
746	ICT	Information and Communications Technology
747	IEC	International Electrotechnical Commission
748	IEEE	Institute of Electrical and Electronics Engineers
749	IoT	Internet of Things
750	ISAC	Information Sharing and Analysis Center
751	ISO	International Organization for Standardization
752	ITA	International Trade Administration
753	H-KPI	Holistic Key Performance Indicators
754	KPI	Key Performance Indicator
755	NIST	National Institute of Standards and Technology
756	NITRD	Networking and Information Technology Research and Development
757	NSF	National Science Foundation
758	NTIA	National Telecommunications and Information Agency
759	OKN	Open Knowledge Network
760	OSTP	Office of Science and Technology Policy
761	PSCR	Public Safety Communications Research (NIST program)
762	R&D	Research and Development
763	RDT&E	Research, Development, Test and Evaluation
764	S&CC	Smart and Connected Community (NSF program)
765	SCSD	Smart Connected Systems Division
766	SCI	Smart City Infrastructure (NIST program)
767	SDO	Standards Development Organization
768	SMART	Specific, Measurable, Achievable, Realistic, Timely
769	STEAM	Science, Technology, Engineering, Art, and Mathematics
770	TAG	Technical Advisory Group

771 **Appendix A. Integrating a Community Perspective into the GCTC Strategic Plan**

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778

779 *This Appendix is intended to capture community perspectives related to the NIST GCTC and smart cities,*
780 *generally. These perspectives were generated during the course of three workshops involving GCTC*
781 *leadership, and incorporate ideas and concepts from industry, academia, government, and other*
782 *organizations. This report was prepared as an account of a workshop. It is intended to document external*
783 *perspectives and does not necessarily represent official NIST positions.*

784 **5.1. Background on the GCTC Strategic Planning Process**

785 In 2022, NIST initiated a cooperative agreement with George Mason University (GMU) to coordinate the
786 development of an integrative and supportive community-centric strategy to complement the NIST SCI
787 program and inform and strengthen the GCTC in its role as a nation-wide public private partnership. This
788 activity included a workshop series with the intention to define guiding principles, identify opportunities
789 for advanced technology research, development, and application of smart city concepts and technologies,
790 and develop mission and vision statements to guide the future of the organization.

791 In August 2022, the GCTC leadership convened at the George Mason University campus in Arlington,
792 Virginia in the first workshop in a three-part series. The workshop was attended by the co-chairs of the
793 twelve GCTC Technology Sectors (Figure 2), each of whom had long-standing participation and leadership
794 in the GCTC, as well as experience in designing and guiding smart city endeavors within their own
795 communities. In all, 28 members participated in one or more of the three workshops, and are listed in the
796 Acknowledgements page on page V of this document. (Owing to the COVID-19 pandemic and impact on
797 travel, two of the sessions accommodated virtual participation by some members). The first workshop,
798 sponsored by the Center for Advancing Human-Machine Partnerships (CAHMP) at GMU, was intended to
799 establish a strategic research vision for the GCTC. The workshop provided the leadership of the GCTC
800 Technology Sectors and other attendees an opportunity to better understand how the GCTC interacts with
801 internal and external partners to achieve technology deployment and implementation for the purpose of
802 informing the strategic vision. This workshop was followed by a September 2022 workshop sponsored by
803 the City of Coral Gables, Florida, and was held in the Public Safety Headquarters Smart Building.
804 Augmenting the findings of the first workshop, the second workshop was designed to identify the specific
805 priorities and activities of the strategic plan. In June 2023, a third workshop was held at Portland State
806 University in Portland, Oregon to finalize the GCTC community-centric strategic plan and goals.

807 Synthesized results from the workshop series were intended to: 1) inform and guide the strategic direction
808 of the GCTC organization to benefit communities and the public; and 2) yield insights into the complex

809 and interdependent challenges of disseminating and implementing advanced technology systems in the
810 smart and connected communities vision. The results of the discussions and planning process provided a
811 real-world, community-level perspective for the GCTC Strategic Plan, and outcomes of the workshop series
812 were incorporated into the GCTC Strategic Plan 2024-2026. A Workshop Report is issued separately and
813 posted on the GCTC OpenCommons web portal. (Establishment of the GCTC resource and OpenCommons
814 portal was one of the major outcomes of the GCTC community planning process and is described briefly
815 in section 4.2 above). Other key outcomes from the strategic planning process are highlighted below.

816 **5.2. Purpose and Objectives**

817 The goal of the workshop series was to generate a community-focused perspective on the agenda and
818 priorities to be pursued by GCTC communities and partners. The specific objective of the meetings was to
819 solicit GCTC leadership input to articulate vision and mission statements and to identify forward looking
820 goals and activities for the volunteer organization to inform a community-based strategy for the GCTC, as
821 well as smart and connected communities across the nation. The workshop series served to define a plan
822 for the GCTC community through a facilitated consensus process involving participant representatives from
823 the leadership of the twelve GCTC technology sectors that comprise the GCTC. The overall objectives for
824 identifying new strategic plans for the GCTC in these workshops was: 1) to nurture integrated,
825 multidisciplinary research and development in smart city strategies and technologies; 2) to address
826 capability gaps and national challenges in smart city technologies; and 3) to identify new opportunities to
827 collaborate with federal, state, county, and municipal partners to define requirements and validate
828 approaches for enhancing community services and efficiencies.

829 **5.3. GCTC Community Vision and Mission**

830 At the conclusion of the workshop series, the GCTC leadership group arrived at consensus on the vision
831 and mission statements for the organization. This vision and mission will begin to provide broad guidance
832 and define priorities for the GCTC local and regional communities to assist in building a common approach
833 to GCTC smart city initiatives, creating a common reference point for future planning of the GCTC program
834 and organization. The vision and mission statements generated by the group during the workshop series
835 are:

836 **Vision:** GCTC communities that have achieved a digital transformation enabling
837 them to become more vibrant, resilient, equitable, sustainable, agile, and
838 connected.

839 **Mission:** To support the digital transformation of communities by providing
840 trusted, unbiased information, best practices, and systematic, integrated
841 methodologies that help communities become more sustainable, equitable,
842 resilient, and livable.

843 The key outcome of the workshop series was a consensus-based structure and set of objectives for the
844 GCTC defining the future functions and relationships for the community and regional public private
845 partnerships that characterize the GCTC. Organizational goals refer to the overarching objectives or

846 outcomes that the GCTC aims to achieve in the next 2-5 years. The GCTC goals provide a sense of direction
847 and purpose guiding the organization’s strategic decision-making and resource allocation.

848 **5.4 Community-Level Principles for Guiding the GCTC Program**

849 Through the Strategic Planning Workshop series, the GCTC leadership identified five principles that will
850 guide public outreach, civic engagement, and project adoption into the future. While specific GCTC
851 community projects, agendas, and priorities will continue to evolve (just as smart city technologies
852 inevitably will), these principles will form the core of the program and its relationship to communities, for-
853 profit and non-profit organizations, and research institutes.

- 854 1) Provide any city or community with the opportunity to participate in GCTC activities and create an
855 affiliation with other smart city and community programs, and encourage the free and open access
856 to knowledge, resources, and experience.
- 857 2) Encourage and support smaller communities who often cannot attract sufficient investment from
858 the private sector to pursue smart city digital transformation, and assist in identifying available
859 federal, state, local, and philanthropic funding sources.
- 860 3) Assist in providing access and interpreting national and global guidelines (e.g., the NIST
861 Cybersecurity Framework 2.0; U.N. Sustainable Development Goals) as potential foundational
862 documents for pursuing digital transformation of cities and communities.
- 863 4) Provide a U.S.-oriented approach to open standards development of smart city-related technologies
864 and applications that relies on consensus and market actors to design and develop standards that
865 are voluntary, consensus-based and private sector led.
- 866 5) Encourage students, early career professionals, and young people to become engaged in smart city
867 technologies, concepts, and projects through such approaches as digital games, hackathons, social
868 media and tech demonstrations and simulations in smart cities and communities.

869 **5.5. GCTC Research and Development priorities for 2024-2026**

870 During the three workshops, broad goals for the GCTC organization were distilled into a number of specific
871 project goals and undertakings based on a consensus of the leadership. Some of these projects will be
872 adopted within specific GCTC communities as prototypes or directed to potential research and development
873 efforts by collaborative teams, local communities, or partner organizations. Timelines for development of
874 these efforts will evolve as this strategy is further refined and implemented. The following efforts were
875 identified as the top areas of smart city technology and concept development and will be pursued as GCTC
876 priorities.

- 877 1) Define mechanisms that can help translate community needs into actionable goals using smart
878 technologies that ultimately engage the community in improving quality of life for residents. More
879 specifically, develop standardized approaches that help communities know where to start and how
880 to document their progress and successes.
- 881 2) Create an organizational structure to enable different entities involved in GCTC to operate together
882 and independently (i.e., separately within a community, or collaboratively across a region). Define

- 883 community strategies that can help GCTC engage different kinds of communities in pursuing smart
884 city goals and initiatives (e.g., tribal, rural, small towns, and metropolitan cities).
- 885 3) Establish a systematic structure and methodology for design of a Key Performance Indicators
886 (KPIs) Dashboard (Templates, KPIs, Application Programming Interfaces (APIs), Standards) and
887 create a publishable mechanism (knowledge base) incorporating methodologies for differing city
888 infrastructure sectors.
- 889 4) Catalyze communities around the country to start smart city programs, conduct technology pilots
890 and implement solutions that showcase the value of the GCTC organization. Identify opportunities
891 and purchasing and contractual vehicles to promote and accelerate the deployment of smart
892 community technologies.
- 893 5) Initiate projects that require multiple GCTC technology sectors to work together in ecosystem
894 development. Establish an alignment across sectors and sponsor live pilots to demonstrate
895 collaborative planning and implementation.
- 896 6) Establish enduring relationships with university research programs related to smart cities and assist
897 with emergent programs, and engage professors, graduate, and undergraduate students in smart city
898 research and development. Develop a strategy for assisting communities in partnering with research
899 universities and applying for funding for equitable infrastructure projects.
- 900 7) Update the existing knowledge base of Action Cluster projects and build a semantic structure that
901 frames the applied integrated knowledge. Build a catalog of these projects to extract relevant KPIs
902 and promote successful projects and organizations.
- 903 8) Build, validate, and promote open-source solutions to remove barriers to community access, cost,
904 and technical capabilities, and create a unified, socio-technological framework for the digital
905 transformation of communities.
- 906 9) Develop training resources for GCTC member communities to increase knowledge and capabilities
907 including social network tools to permit individuals and organizations within the GCTC to connect,
908 meet, learn and interact with the broader community. Create an "Executive Summary" version of
909 the GCTC strategic plan for city officials and community leaders with non-technical, non-scientific
910 language oriented to problem-solving, risk assessment, value generation, and growth opportunities.
- 911 10) Involve high school and university students, city officials, and community volunteers in GCTC to
912 focus on the future of communities and cities and prepare the workforce of the future to grow
913 industry and government leaders and generate interest in public service and civic education/design
914 among the next generation of U.S. citizens and community residents.

915 **5.6. Summary and Path Forward for the GCTC**

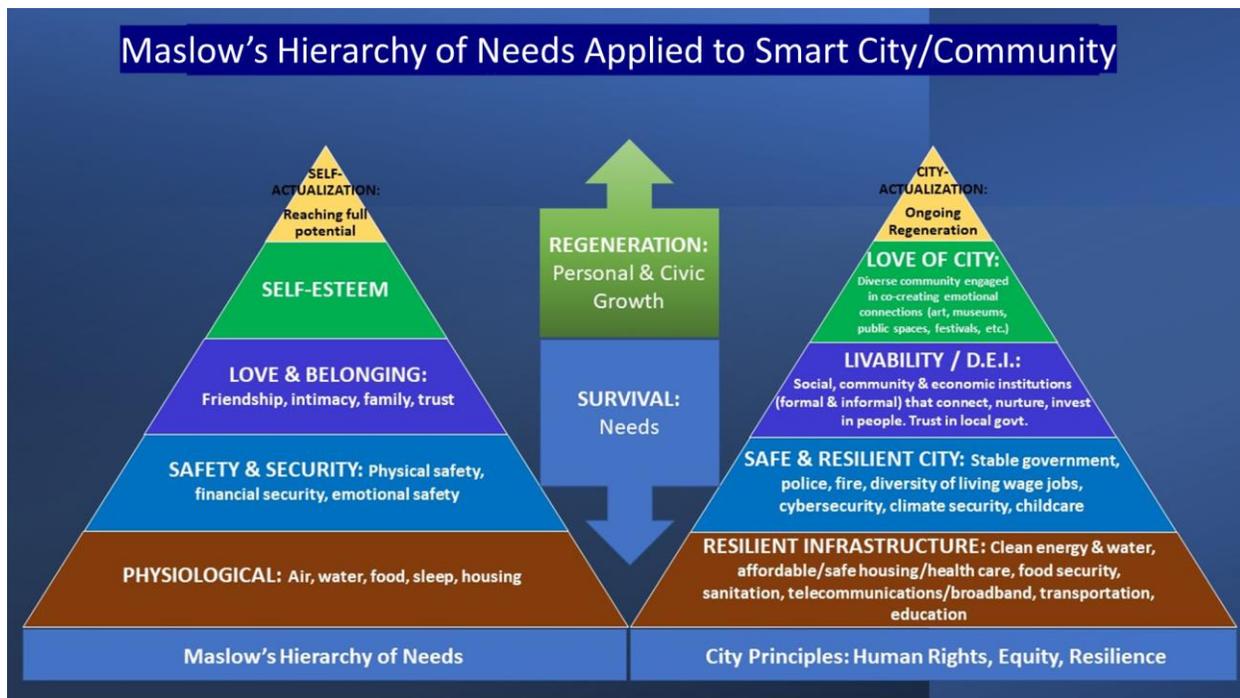
916 As a trusted organization with national and international experience in smart cities, the GCTC and its
917 member cities comprise a team with depth and breadth of knowledge to assist new communities in achieving
918 their specific goals toward digital transformation. By leveraging the institutional knowledge and scientific
919 credibility of NIST, the GCTC has the potential to generate urban and rural living laboratories and assist
920 communities in conducting pilots of smart city technologies.

921 As in many technical fields, city municipal planning is often siloed into bureaus (e.g., planning,
922 transportation, parks and recreation, public works, etc.). The GCTC can assist communities in developing
923 a holistic approach to community planning at multiple levels and perspectives. Smart technology design
924 paired with human-centered urban design opens the opportunity to leverage generated data incorporating
925 an evidence-based model to inform decision making at the city or community level, and more broadly
926 disseminate outcomes and lessons learned across the research and academic communities.

927 Most cities have generated massive amounts of data but may not understand—or have the technical
928 capabilities—to translate that data into evidence about what works and what does not. Starting with a
929 baseline assessment of the built environment, available data and existing services can provide a foundation
930 to work toward progressive improvement to ensure that cities and communities use limited resources in the
931 most efficient and cost-effective way. Therefore, a core program goal for the GCTC is to assist cities and
932 communities to understand “what to measure, and how to measure it” in order to achieve the community’s
933 smart city program goals.

934 Understanding interactions and relationships among diverse factors is fundamental to a holistic
935 understanding of a smart city as an ever-growing network of sensors, data streams, and service platforms,
936 accessed via digital information technologies, in alignment with community objectives, priorities, and
937 measured outcomes. As a way of depicting the relationships and defining a structure for community
938 relationships, the GCTC has begun developing a model of community functions based on Abraham
939 Maslow’s well-known Hierarchy of Human Needs [11]. Figure 6 offers an initial vision of this concept.

940



941
942 Figure 6. Application of Abraham Maslow's Hierarchy of Human Needs to the Smart City [11]
943 © 2022 Smart City Diaries (smartcitydiaries.com/main/). Used with permission.

944 As depicted in Figure 6, city needs and aspirations are built on a foundation that provides for the most basic
945 services: security and safety; public health; access to water and food; reliable electrical power and
946 accessible communications. Higher up in the development of a smart city, however, fundamental priorities
947 for efficiency in delivery of basic city services begin to reflect aspirations for community integrity and
948 livability, economic stability and equity, and quality of life across all of the communities and neighborhoods
949 within a city or region. As noted above (and depicted in Figures 3 and 4) the current goal for the GCTC—
950 and for smart city planning in general—is no longer to focus on the integration of new technologies, or
951 even the collection and management of big data, but rather the use of digital resources, information, and
952 capabilities to achieve measurable improvements in security, livability, and quality of life for all residents,
953 and to aid in establishing trusted relationships between government, private sector enterprise, organizations
954 and citizen groups, and the communities that define a smart city.

955 The GCTC program can assist communities in articulating a clear rationale for pursuing smart city
956 initiatives and infrastructure through its network of educational institutions, experienced local governments,
957 industry partners and federal, state, and local agencies. Any city or community has the opportunity to join
958 and participate in the GCTC and create affiliations with other smart cities and programs and to design a
959 program for digital transformation, whether it is a large metropolitan city, an underserved inner-city
960 neighborhood, or a rural community in an agricultural region.

961 By working with the GCTC, cities can establish an objective, quantitative and qualitative baseline of the
962 built environment, community assets and resources, and identify opportunities for improving efficiencies
963 and effectiveness in delivery of city services. The GCTC program can help cities understand where to begin
964 to improve their infrastructure and technology assessment processes and to measure progress by identifying
965 holistic KPIs, eliciting citizen priorities, addressing community needs, and establishing methods for
966 measuring and understanding relationships between city infrastructure, platforms, and services.

967 The GCTC leadership believes that a co-designed and agile orientation drawing from the collective
968 experiences of GCTC communities and the relationship with NIST offers a clear path forward for positive
969 transformation of cities. Through the adoption of digital technologies based on common standards and
970 frameworks and a collaborative and co-designed approach involving the broad constituencies and
971 stakeholders, each city and community is capable of achieving its goals for digital transformation. The
972 GCTC leadership is committed to sharing knowledge of smart cities deployments with other cities and
973 assisting in developing an integrative framework grounded in real-world experience and applications to
974 guide communities in digital transformation and achievement of their smart city vision.

975

976 **Appendix B. Citations from current U.S. Federal Agency Strategies relevant to the NIST**
977 **GCTC Program and Smart Cities**

978 This appendix contains selected quotations and sections from current federal strategy documents that are
979 relevant to U.S. research and development, transition, and adoption of technologies for smart and connected
980 communities. While there is no designated federal coordinating office for smart technologies, systems, or
981 communities, these citations point to a set of common characteristics and requirements that are identified
982 at the federal level and directly engage or involve collaboration and coordination with state, local, tribal,
983 and territorial (SLTT) authorities and with cities and communities across the nation.

984

985 **EXECUTIVE OFFICE OF THE PRESIDENT**

986 **United States Government National Standards Strategy for Critical and Emerging Technology**
987 **(May 2023). The White House. Washington, D.C. <https://www.nist.gov/standardsgov/usg-nss>.**

988 “The United States will prioritize efforts for standards development for a subset of CET that are
989 essential for U.S. competitiveness and national security ...

990 “There are also specific applications of CET that departments and agencies have determined will
991 impact our global economy and national security. The United States will focus standards
992 development activities and outreach on these applications, which include:

993 • Automated and Connected Infrastructure, such as smart communities, Internet of Things, and
994 other novel applications.

995 • Automated, Connected, and Electrified Transportation, including automated and connected
996 surface vehicles of many types and unmanned aircraft systems, many of which may be electric
997 vehicles (EVs), along with the safe and efficient integration into smart communities and the
998 transportation system as a whole, including standards to integrate EVs with the electrical grid and
999 charging infrastructure;

1000 • Cybersecurity and Privacy, which are cross-cutting issues critical to enabling the development
1001 and deployment of emerging technologies and promote the free flow of data and ideas with trust.

1002

1003 **EXECUTIVE OFFICE OF THE PRESIDENT** MEMORANDUM M021-32 (27 Aug 2021)

1004 **Multi-Agency Research and Development Priorities for FY 2023 Budget**

1005 [MEMORANDUM FOR THE HEADS OF EXECUTIVE DEPARTMENTS AND AGENCIES](https://www.whitehouse.gov/wp-content/uploads/2021/07/M-21-32-Multi-Agency-Research-and-Development-Priorities-for-FY-2023-Budget.pdf)
1006 [\(\[whitehouse.gov\]\(https://www.whitehouse.gov\)\)](https://www.whitehouse.gov/wp-content/uploads/2021/07/M-21-32-Multi-Agency-Research-and-Development-Priorities-for-FY-2023-Budget.pdf)

1007 [https://www.whitehouse.gov/wp-content/uploads/2021/07/M-21-32-Multi-Agency-Research-and-](https://www.whitehouse.gov/wp-content/uploads/2021/07/M-21-32-Multi-Agency-Research-and-Development-Priorities-for-FY-2023-Budget.pdf)
1008 [Development-Priorities-for-FY-2023-Budget-.pdf](https://www.whitehouse.gov/wp-content/uploads/2021/07/M-21-32-Multi-Agency-Research-and-Development-Priorities-for-FY-2023-Budget.pdf)

1009

1010 1. **Catalyze research and innovation in critical and emerging technologies.** Agencies should
1011 collaborate to promote world-leading research and innovation boosting American industries and
1012 quality American jobs in critical and emerging technologies, including artificial intelligence (AI),

1013 quantum information science (QIS), advanced communications technologies, microelectronics,
1014 high-performance computing, biotechnology, robotics, and space technologies ... “[and] should
1015 actively pursue public-private partnerships, as allowable, that will expedite American leadership in
1016 these technologies to grow our inclusive 21st-century digital economy. (p. 3)

1017 2. **Innovation for equity.** The President has implemented a whole-of-Government equity agenda.
1018 Federal agencies should prioritize R&D investments in programs with strong potential to advance
1019 equity for all, including people of color and others who have been historically disadvantaged,
1020 marginalized, and adversely affected by persistent poverty and inequality. As part of this focus,
1021 agencies should consider programs and initiatives, including community-level capacity building
1022 and training that expand equitable inclusion in Federal science and technology programs and the
1023 use of scientific and technological innovation to advance equitable outcomes. For example, open
1024 science and other participatory modes of research, such as community-based datahubs that give
1025 citizens access to information and data, as well as community-engaged research that respectfully
1026 provides opportunities for the participation in science and technology of those historically excluded
1027 from the scientific enterprise. (p.3)

1028 3. **National security and economic resilience.** Agencies’ plans and budgets should support the
1029 research, development, and application of technologies that protect American security and
1030 strengthen our economic resilience. ... and new capabilities for defending critical infrastructure
1031 and sensitive networks against cyberattacks and supply chain attacks, including improved
1032 authentication mechanisms, zero-trust architectures, and better intrusion detection capabilities.
1033 Investments in economic resilience should emphasize technologies that ensure safe, clean, and
1034 reliable access to critical products, materials and minerals, including new manufacturing and
1035 biomanufacturing processes that can cost-effectively produce key goods on demand. (p. 4)

1036 4. **Other R&D Program Guidance.** To build a trustworthy and engaged U.S. science and technology
1037 (S&T) enterprise, agencies should prioritize making Federally funded R&D: open to the public in
1038 a findable, accessible, interoperable, and reusable way; more rigorous, reproducible, and
1039 transparent; safe and secure; grounded in assessment of ethical, legal, and societal implications ...
1040 “including community-level capacity building and training ... and the use of scientific and
1041 technological innovation to advance equitable outcomes. (p. 4).

1042

1043

1044 **U.S. CONGRESS. Public Law 117-58 Infrastructure Investment and Jobs Act, Nov 15 2021**
1045 U.S. Congress. Infrastructure Investment and Jobs Act [H.R. 3684]. Public Law 117-58. 15 Nov 2021.
1046 <https://www.congress.gov/bill/117th-congress/house-bill/3684/text>

1047 SEC. 25002. SMART COMMUNITY RESOURCE CENTER.

1048 (1) RESOURCE CENTER.—The term “resource center” means the Smart Community Resource Center
1049 established under sub-section (b).

1050 (2) SMART COMMUNITY.—The term “smart community” means a community that uses innovative
1051 technologies, data, analytics, and other means to improve the community and address local challenges.

1052 (b) ESTABLISHMENT.—The Secretary shall work with the modal administrations of the Department and
1053 with such other Federal agencies and departments as the Secretary determines to be appropriate to make
1054 available to the public on an Internet website a resource center, to be known as the “Smart Community
1055 Resource Center”, that includes a compilation of resources or links to resources for States and local
1056 communities to use in developing and implementing—

1057 SEC. 25003. FEDERAL SUPPORT FOR LOCAL DECISIONMAKING.

1058 (a) LOCAL OUTREACH.—To determine the data analysis tools needed to assist local communities in
1059 making infrastructure decisions, the Director of the Bureau of Transportation Statistics shall perform
1060 outreach to planning and infrastructure decision-making officials in units of local government and other
1061 units of government, including a geographically diverse group of individuals from—

- 1062 (1) States;
- 1063 (2) political subdivisions of States;
- 1064 (3) cities;
- 1065 (4) metropolitan planning organizations;
- 1066 (5) regional transportation planning organizations; and
- 1067 (6) federally recognized Indian Tribes.

1068

1069

1070 **U.S. DEPARTMENT OF COMMERCE Strategic Plan 2022-2026. Innovation, Equity, and**
1071 **Resilience.** [Strategic Plan | U.S. Department of Commerce](#)

1072 1. **Strategic Objective 1.2. Accelerate the development, commercialization, and deployment of**
1073 **critical and emerging technologies.** [Strategy 2.](#) Strengthen U.S. participation in technical
1074 standards development. NIST will work to increase diverse participation and leadership in
1075 standards development committees, invest in relevant research activities, and support efforts to
1076 improve the overall stakeholder experience in standards development. [Strategy 3.](#) The Department
1077 will improve the transfer and commercialization of technology from Federal Government labs
1078 through efforts like NIST’s lab-to-market program and by helping entrepreneurs access new
1079 technology and patent innovations. The Department will also invest in innovation ecosystems
1080 incentivizing partnerships between industry; institutions of higher education; nonprofits; and
1081 Federal, state, and local governments to promote a seamless innovation pipeline. (p. 13)

1082 2. **Strategic Objective 2.1. Drive equitable, resilient, place-based economic development and job**
1083 **growth.** [Strategy 3.](#) To scale the next generation of technological innovation, maintain global
1084 competitiveness, and ensure everyone benefits from the innovation economy, the Nation must
1085 harness the potential of all regions, workers, and businesses. This means expanding support for
1086 innovation ecosystems all across America, beyond a handful of urban centers. ... The National
1087 Institute of Standards and Technology (NIST) will strengthen efforts to leverage its nationwide
1088 expertise, facilities, and partnerships, as well as provide funding and technical assistance to enhance
1089 information sharing among researchers and entrepreneurs. This expanded integrated network will
1090 help ensure more efficient and equitable diffusion of the technology and knowhow needed to
1091 innovate. (p. 31).

- 1092 3. **Strategic Objective 3.3 Accelerate development and deployment of clean technologies.**
1093 Strategy 3 NIST and NOAA will partner to support the development of climate-ready
1094 infrastructure. NIST Laboratories will provide access to unique facilities and testbeds to accelerate
1095 the development of climate mitigation technologies ... and improve the performance and accuracy
1096 of climate observing systems. These programs allow communities to prepare for, respond to, and
1097 mitigate the impacts of climate change and enable industry to advance vital technologies that will
1098 reduce the Nation's carbon footprint. (p.48).

1099

1100

1101 **NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY 2021-2025 Strategic Plan**

1102 <https://www.nist.gov/system/files/documents/2021/06/04/11.%20Sberegaeva%20NSP%20VCAT%20update%20%281%29.pdf>
1103

- 1104 1. **Vision:** NIST will be the world's leader in creating critical measurement solutions and promoting
1105 equitable standards. Our efforts stimulate innovation, foster industrial competitiveness, and
1106 improve the quality of life. (p. 3)

1107 NIST is the sole government laboratory with a mission to enhance industrial competitiveness, and
1108 it does that through its unique role in measurement science, standards, and technology. In fulfilling
1109 this mission, NIST has an outsized impact on the U.S. economy, quality of life, and national
1110 security. (p.4)

- 1111 2. **Action 7.** The impact of NIST's work is directly correlated to our ability to ensure our stakeholders
1112 and customers' expectations are met for high quality products and services, knowledge of best
1113 business practices, and objectivity in all technical and business decisions. Increase the successful
1114 transfer of NIST-developed technologies by applying Baldrige best practices to streamline and
1115 enhance customer and stakeholder engagements. (p. 10)

- 1116 3. **Action 8.** Improve stakeholder awareness of NIST by clarifying and sharpening NIST's strategic
1117 communications and initiating an effort to rebrand NIST.

1118 Improve consistency of messaging in communications to stakeholders will help them identify and
1119 share NIST's priorities, capabilities, and value. NIST must ensure its priorities are clear and all
1120 communications to broad audiences in industry, academia, government, media, the broader public,
1121 and within NIST are aligned with its core messages. (p. 10)

- 1122 4. **Strategic Goal 1: Position NIST to Advance U.S. Measurement Science and Innovation** Many
1123 of the emergent national priority issues that NIST is asked to address are cross-disciplinary and
1124 draw upon expertise available across NIST. NIST must remove barriers between organizational
1125 units to best leverage the world-class expertise contained across the institute. NIST should explore
1126 the range of partnership approaches and external engagement models to continue to effectively
1127 fulfill its mission. (p. 13)

- 1128 5. **Strategic Objective 1.1:** Increase agility, promote collaboration, and maintain technical excellence
1129 to strategically advance emerging technologies and address national needs. (p. 13).

- 1130 • Foster a culture that promotes cross-OU collaboration, both socially and technically, including
1131 in areas of national need. (p. 13)
- 1132 6. **Strategic Objective 1.3:** Develop creative models that strategically expand our external
1133 engagement and impact, aligned with our mission to maximize value of technical programs. (p. 13)
- 1134 • Take a more purposeful approach to identifying and nurturing external partnerships.
- 1135 • Establish and implement rigorous, fair, and transparent mechanisms to assess the effectiveness
1136 and impact of existing partnerships.
- 1137 7. **Strategic Goal 2: Maximize NIST Stakeholder Impact through High-Value Service Delivery.**
- 1138 NIST engages in technology transfer working directly with companies and organizations locally
1139 and nationally to transfer technology developed in the NIST labs. For NIST to accomplish its
1140 mission, our research results must reach the private sector for implementation. While NIST has a
1141 strong reputation for technical excellence, it does not have a strong “brand” for which it is readily
1142 identified. (p. 15)
- 1143 8. **Strategic Objective 2.1:** Facilitate the transfer of NIST knowledge, inventions, and technologies
1144 from the laboratory to the marketplace. (p. 15)
- 1145 • Improve communications about NIST tech transfer processes and policies.
- 1146 • Ensure businesses are aware of opportunities to transfer NIST knowledge and technologies.
- 1147 • Pilot new efforts and policies for NIST to catalyze technology transfer improvements.
- 1148 9. **Strategic Objective 2.2:** Provide high quality products and services that NIST’s customers and
1149 other key stakeholders value. The lack of a unifying brand and clearly articulated priorities
1150 supporting that brand are major issues that limit NIST’s effectiveness in reaching stakeholders.
- 1151 • Adopt organizational branding best practices to enhance NIST’s reputation with key
1152 stakeholders as a leader in advancing innovation and economic impact.
- 1153 • Enhance internal and external communications management and policies in ways that
1154 encourage a “One NIST” culture and support organizational branding efforts.
- 1155 • Implement strategic communications planning led by Public Affairs, with participation by
1156 all NIST operating units, focused on priority messages, tactics, and metrics of success. (p.
1157 15)
- 1158 10. **Strategic Goal 3: Create the Infrastructure for a 21st Century Research Institution.** Emerging
1159 scientific, engineering, and cyber research are relying more critically on computation, data, and
1160 informatics to fulfill the NIST mission of enhancing U.S. industry and innovation. (p. 17)
- 1161 11. **Strategic Objective 3.1:** Facilitating a next-generation research and data infrastructure.
- 1162 Public-private partnerships in science and technology using next-generation instrumentation that
1163 deliver research results to our community will extend our metrology expertise into the data
1164 sciences, computational frameworks, and networked architectures. Adapting our mode of operation
1165 for this research-driven infrastructure serving cross-organizational goals is essential for our mission
1166 to be successful into the future.

- 1167 • Provide a sustainable open access research framework. (p. 17)
- 1168 12. **Strategic Objective 3.4. Adopt and transition to modern business systems and operational**
1169 **practices to improve transparency and agility.**
- 1170 To improve business systems and services, NIST needs to implement a business system evaluation
1171 tool or practice, a discretionary funded program, a business system review, and standard business
1172 workflows. (p. 18)
- 1173 • Streamline business system workflows (via adoption Salesforce for GCTC CRM).
- 1174 13. **Strategic Goal 4: Build a One NIST Culture.** Our workforce is the most critical asset of the
1175 institution, and future success or failure will hinge on the steps we take now to ensure its health and
1176 effectiveness for years and decades to come. People want to work in an environment that is
1177 accepting of all backgrounds and promotes equality and fairness ... in an environment where
1178 everyone feels engaged, appreciated, and empowered. (p. 19)
- 1179 14. **Strategic Objective 4.2:** Create an engaged, empowered, and agile NIST workforce aligned with
1180 the One NIST vision and NIST core values.
- 1181 • Incentivize cross-collaboration between different OUs and improve the engagement and
1182 empowerment of the NIST workforce. (p. 19)

1183

1184

1185 **NETWORKING AND INFORMATION TECHNOLOGY RESEARCH AND DEVELOPMENT**
1186 **Smart Cities & Communities Task Force October 2018**

1187 **Connecting and Securing Communities. A Guide for Federal Agencies Supporting Research,**
1188 **Development, Demonstration, and Deployment of Technology for Smart Cities and Communities**

1189 <https://www.nitrd.gov/pubs/NITRD-Connecting-Securing-Communities-Federal-Guide-2018.pdf>

- 1190 1. Smart city/community projects are inherently state and local efforts, but there are many ways for
1191 the Federal government to support these efforts, including R&D leading to new innovations,
1192 advising on security and resilience, sharing data, and helping to track progress. To be an effective
1193 partner, Federal agencies must align their efforts with state, regional, and local needs while
1194 incorporating appropriate public-private and public-academic partnerships. (p. 2)
- 1195 2. Federal smart city/community activities need to be iteratively informed by cities and communities
1196 and should reflect the diverse challenges faced by cities/communities of all types (e.g., rural,
1197 suburban, urban, peri-urban, tribal, small, and large). (p. 3)
- 1198 Considerations should include privacy and security, social, behavioral, and economic factors (e.g.,
1199 health, education, and socioeconomic status), effective Internet access, and outreach and
1200 educational resources. Finally, Federal support for technologies and programs intended to advance
1201 smart city efforts must be designed to work within a wide variety of resource environments, policy
1202 settings, and legal and regulatory frameworks. (p.3)

- 1203 3. The challenge for cities and communities lies in spanning traditional boundaries. Interagency
1204 coordination and the convening power of Federal agencies can catalyze enhanced cooperation and
1205 new partnerships across agencies, sectors, and stakeholders. (p. 4)
- 1206 4. The Federal Government can foster industry-driven standards; sharing of successful practices
1207 domestically and internationally; interoperable and replicable solutions to increase global trade,
1208 investments, and export opportunities; and provide global leadership for smart cities/communities.
1209 (p. 4)
- 1210 5. “The transition of research innovations to practice is critical to ensure that smart city/community
1211 innovations benefit cities and communities, and their residents, and that they yield the greatest
1212 return on investment for the Federal Government. This requires an approach that bridges the chasm
1213 between fundamental science and engineering research and full production. Federal agencies must
1214 work synergistically with industry, nongovernmental organizations, and other stakeholders to
1215 shepherd innovations using transition-to-practice programs to efficiently move research findings to
1216 translation and adoption, and fully realize their value.” (p. 8.)

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1219 **DEPARTMENT OF HOMELAND SECURITY Strategic Plan Fiscal Years 2020-2024**

1220 [The DHS Strategic Plan Fiscal Years 2020-2024](#)

1221 https://www.dhs.gov/sites/default/files/publications/19_0702_plcy_dhs-strategic-plan-fy20-24.pdf

1222

1223 **1. Goal 5: Strengthen Preparedness and Resilience**

1224 **Objective 5.1: Build a National Culture of Preparedness**

1225 The United States must strive for a future where disasters cause fewer disruptions and less
1226 destruction throughout our communities. The prevalence of disaster declarations and recovery costs
1227 over the last decade demonstrate the need for local communities to improve their preparedness for
1228 predictable natural events. Building more resilient communities and investing in mitigation
1229 measures are the best ways to reduce risks to local communities arising from the loss of life,
1230 economic disruption, and infrastructure restoration. (p. 44)

1231 **FEDERAL EMERGENCY MANAGEMENT AGENCY FEMA Strategic Plan 2022-2026**

1232 [2022–2026 FEMA Strategic Plan | FEMA.gov](#) <https://www.fema.gov/about/strategic-plan>

1233 **1. Objective 2.2 Build a Climate Resilient Nation**

1234 Many communities are faced with aging infrastructure, which can increase risk from major
1235 disasters. As the frequency of these disasters accelerates, the agency must increase climate
1236 adaptation investments across the nation. ... To have the greatest impact, FEMA encourages smart
1237 investments in system-based, community-wide projects to protect those at the most severe and
1238 persistent risk. For example, helping a community adopt and enforce disaster resistant building

1239 codes improves the resilience of the whole community. Research has shown that every dollar
1240 invested in building to the latest codes and standards results in \$11 of future avoided losses. (p. 17)

1241 **Objective 2.3 Empower Risk-Informed Decision-Making.**

1242 The future disaster environment will not resemble that of the past, or even what is experienced
1243 today. To build long-term resilience, communities must understand their future risk — and have
1244 the resources and capacity to reduce that risk. ... Collaboration across all parts of communities, at
1245 all levels, will be necessary to develop comprehensive information about local infrastructure, land
1246 use, building code standards, and factors to enable better risk-informed decision making. (p. 18).

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1249 **Department of HEALTH AND HUMAN SERVICES (HHS)**

1250 [Strategic Plan FY 2022 – 2026 | HHS.gov](https://www.hhs.gov/bout/strategic-plan/2022-2026/index.html)

1251 <https://www.hhs.gov/bout/strategic-plan/2022-2026/index.html>

1252 **1. Objective 1.2 Reduce costs, improve quality of healthcare services, and ensure access to safe**
1253 **medical devices and drugs**

1254 Implement and assess approaches to improve healthcare quality, and address disparities in healthcare
1255 quality, treatment, services, and outcomes. Support research and evaluation of expanded use and
1256 availability of telehealth and telemedicine, including effects on quality, access, costs,
1257 reimbursement, and care outcomes and harms, to inform the long-term approach to using telehealth
1258 and to improve access to care for underserved populations

1259 **2. Objective 2.1: Improve capabilities to predict, prevent, prepare for, respond to, and recover**
1260 **from disasters, public health and medical emergencies, and threats across the nation and**
1261 **globe**

1262 Apply lessons learned from the use and application of technology, data, and research to improve
1263 preparedness and health and human services outcomes during emergencies and disasters.

1264 Enhance research, analytic, and learning capabilities through more efficient, accurate, and trusted
1265 collection, application, and integration of data from new and existing data streams across a series of
1266 disciplines, including demographic, environmental, genetic or genomic, biomedical, economic,
1267 geospatial, and ecological data, to better understand health impacts of emergencies and disasters.

1268 Improve coordination and collaboration efforts with federal, state, tribal, local, territorial, and
1269 international partners to enhance integrated surveillance and monitoring capacity to ensure equity in
1270 emergency response planning, coordination, and delivery and sustaining global health security.

1271 Invest in modernizing information technology infrastructure to foster data sharing and inter-
1272 operability across systems in coordination with partners to ensure data insights are representative,
1273 actionable, and readily available to decisionmakers and researchers before, during, and after an
1274 emergency or disaster to inform preparedness, response, and forecasting

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1276 **U.S. DEPARTMENT OF TRANSPORTATION Strategic Plan for FY 2018-2022**

1277 [U.S. Department of Transportation - Strategic Plan for FY 2018 - 2022](#)

1278 [https://www.transportation.gov/sites/dot.gov/files/docs/mission/administrations/office-policy/304866/dot-](https://www.transportation.gov/sites/dot.gov/files/docs/mission/administrations/office-policy/304866/dot-strategic-planfy2018-2022508.pdf)
1279 [strategic-planfy2018-2022508.pdf](https://www.transportation.gov/sites/dot.gov/files/docs/mission/administrations/office-policy/304866/dot-strategic-planfy2018-2022508.pdf)

1280 **1. Strategic Objective 1: Development of Innovation**

1281 Encourage, coordinate, facilitate, and foster world-class research and development to enhance the
1282 safety, security, and performance of the Nation’s transportation system.

1283 Innovation development requires research and active transfer of relevant technologies and practices
1284 to and from private and public sectors, academia, and State, local, and Tribal agencies.
1285 Accordingly, DOT funds and facilitates research that supports the development and deployment of
1286 innovative practices and technologies in the transportation system. Moving forward, DOT will
1287 work with other Federal agencies, research institutions, and the private sector to develop and
1288 enhance new technological tools capable of improving safety, security, and performance of the
1289 transportation system in both urban and rural areas. Priority areas include: improving cybersecurity;
1290 improving transportation infrastructure durability, resilience, and cost effectiveness; and,
1291 improving the movement of goods and people of all abilities. (p. 30)

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1294 **U.S. DEPARTMENT OF ENERGY Office of Energy Efficiency and Renewable Energy (EERE)**

1295 2016-2020 Strategic Plan [EERE Strategic Plan 12.16.15.pdf \(energy.gov\)](#)

1296 [https://www.energy.gov/sites/prod/files/2015/12/f27/EERE Strategic Plan 12.16.15.pdf](https://www.energy.gov/sites/prod/files/2015/12/f27/EERE_Strategic_Plan_12.16.15.pdf)

1297

1298 **1. Goal 3: Improve the energy efficiency of our homes, buildings, and industries (p. 15)**

1299 Demonstrate that Next-Generation Efficient Homes and Buildings are Affordable, Healthy, and
1300 Durable. The 1 million homes and 1.5 billion square feet of commercial buildings typically built
1301 each year, along with significant renovations in existing buildings, provide a unique opportunity to
1302 build in energy waste-cutting measures. EERE’s activities in this area, such as the Building
1303 America program and Challenge Home partnership, will engage designers, home builders, and
1304 building scientists to demonstrate that high performance buildings incorporating new design
1305 options can be built and commercially sold. EERE will develop and leverage energy modeling and
1306 integrated design techniques and whole building verification to address the significant number of
1307 small and medium-sized buildings across the country.

1308 **2. Goal 5: Enable the integration of clean electricity into a reliable, resilient, and efficient grid**

1309 ... new platforms such as smart buildings with advanced sensors and controls have the potential to
1310 reward building owners and users for investing in assets with the ability to help integrate clean
1311 energy and improve the reliability of the system. To fully capture this potential, EERE will
1312 investigate new market and business models—integrating energy supply, demand, and related

1313 building services—that provide new avenues and incentives for consumer participation in clean
1314 energy. One potential model is that of transaction-based energy services, which make use of grid-
1315 responsive building assets to improve system reliability, while ensuring optimal outcomes for all
1316 parties based on pre-defined boundaries. (p. 23)

1317 3. **Goal 6: Lead efforts to Improve Federal Sustainability and Implementation of Clean Energy**
1318 **Solutions**

1319 Collaborate with multiple partners across sectors to develop, test, and implement effective energy
1320 management practices and systematic energy technology deployment. ... EERE will work with
1321 states, municipal governments, universities, hospitals, schools, and the private sector to share
1322 federal advances and learn from them as they utilize technologies, practices, and tools. (p. 29)

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1325 **US DEPARTMENT OF AGRICULTURE Strategic Plan FY 2018-2022**

1326 [USDA Strategic Plan FY 2018 - 2022](#)

1327 <https://www.usda.gov/sites/default/files/documents/usda-strategic-plan-2018-2022.pdf>

1328

1329 1. **Strategic Goal 4: Facilitate Rural Prosperity and Economic Development**

1330 When rural Americans share the same level of infrastructure services as the country’s urban areas,
1331 rural communities can make even greater economic contributions with healthy businesses and
1332 families. Just as economic and social science research informs decision-makers regarding current
1333 trends in rural America and gaps in existing markets, USDA may then provide benefits to rural
1334 American businesses and citizens. USDA will leverage funds, stimulate private-public
1335 partnerships, and engage in collaboration to build rural infrastructure including broadband,
1336 community facilities, safe and affordable housing, health services and facilities, and provide
1337 capacity building to help underserved communities become thriving communities.” ... A
1338 connected rural America enables global commerce for small businesses, precision agriculture, just-
1339 intime manufacturing, efficient transportation, and multiple other productivity benefits. A
1340 connected rural America also ensures modern education, remote training for workforce
1341 development, and cost-efficient and effective healthcare. (p. 33).

1342 2. **Community Infrastructure:** Facilitate and leverage direct investment in community and
1343 commercial infrastructure that supports rural economies. Investment in rural human-services
1344 transportation, utilities, and commercial infrastructure addresses primary business needs, fosters
1345 entrepreneurship, attracts corporate investment, and reduces unemployment. Much-needed
1346 investments in broadband high-speed internet connectivity for schools and libraries, healthcare and
1347 wellness facilities, as well as power, telecommunications, water, and waste management systems
1348 will be prioritized and measured for outcomes. (p. 34)

1349 3. **Strategic Partnerships:** Leverage strategic partnerships with other Federal agencies, State and
1350 local governments, non-profits, and the private sector to increase USDA efficiency and effective-
1351 ness at facilitating rural prosperity and promoting economic development and growth. (p. 35)