


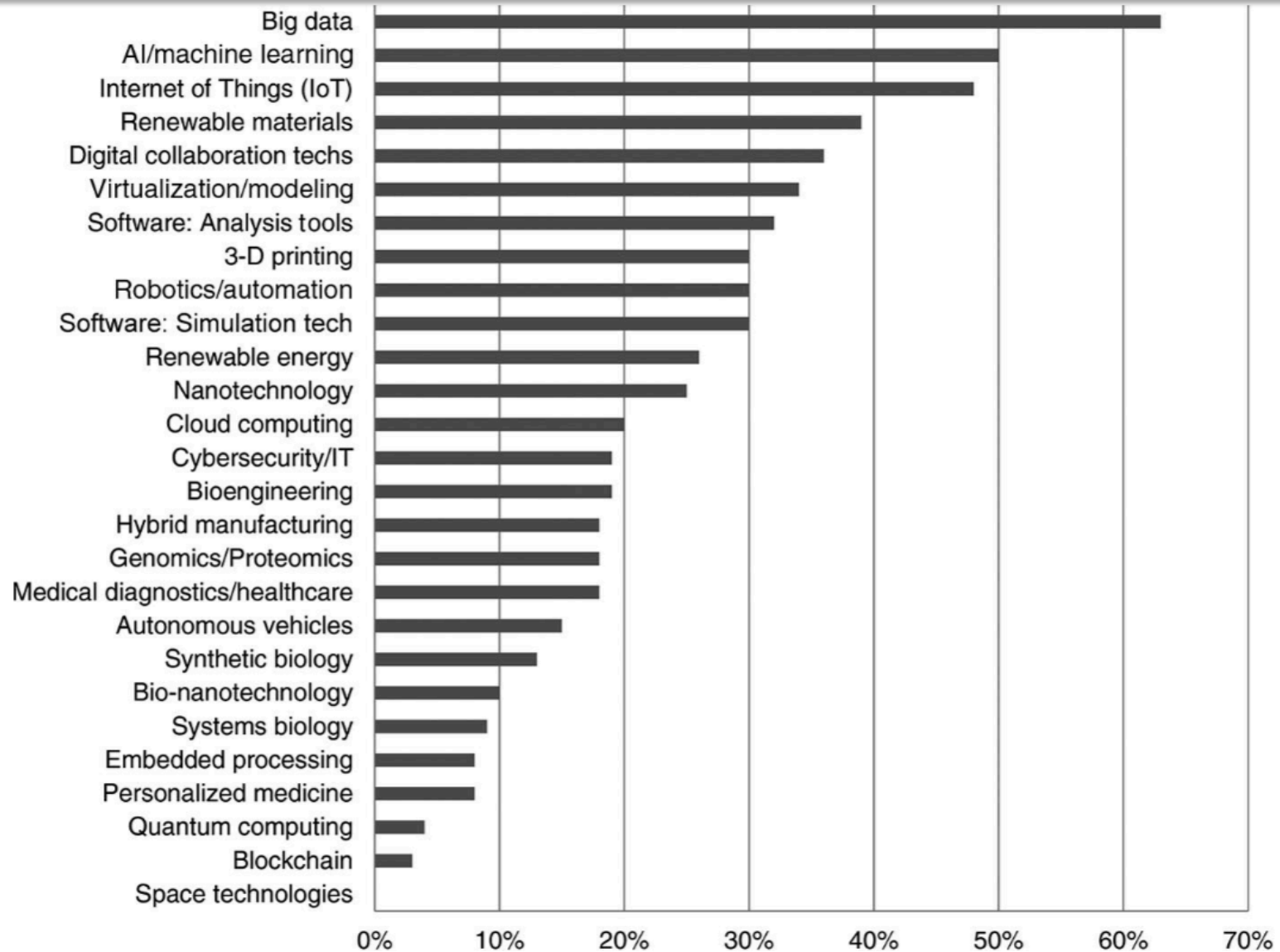


CORPORATE BD STRATEGY DISCUSSION

TOP REASONS COMPANIES WANT TO COLLABORATE WITH PURDUE

- Early engagement with and access to students
 - Future workforce development
 - Leading-edge research work with faculty and students
 - Access to world-class facilities, capabilities, and places
 - Co-work and collaboration with industry partners
 - License to technology and investment in start-ups
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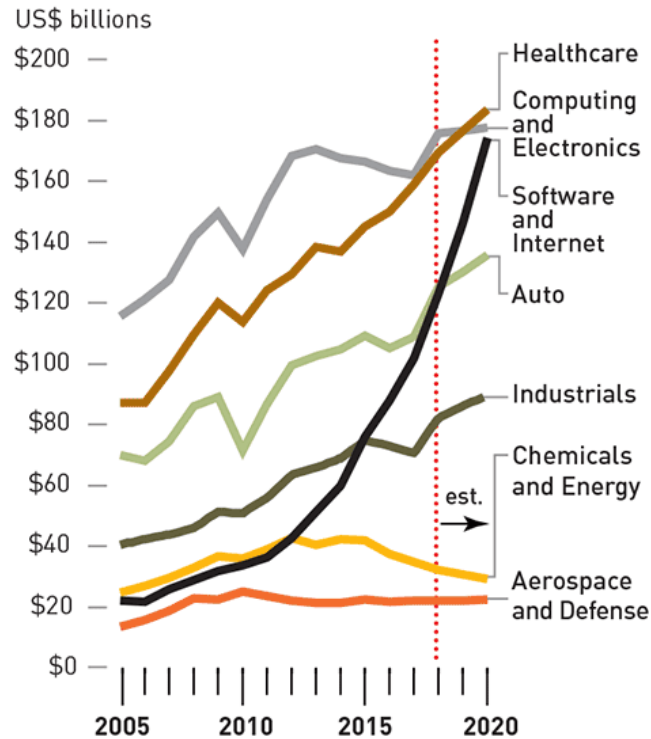
MOST IMPORTANT TECHNOLOGIES NEXT THREE YEARS



CORPORATE R&D SPENDING

R&D Spending by Industry

Companies in the healthcare and software and Internet sectors demonstrated sustained growth in R&D spending, which has been increasing for years in both cases.



Source: Capital IQ data, Thomson Reuters Eikon data, Strategy& analysis

R&D spending among the Global Innovation 1000 overall increased 11.4 percent in 2018, to a record high of **\$782 billion**, reflecting R&D spending increases in all regions and nearly all industries (see “Profiling the Global Innovation 1000”)

The Top 20 R&D Spenders

Total R&D spending by the top 20 companies was \$214.5 billion in 2018. Amazon topped the list with expenditures of \$22.6 billion.

Companies in **RED** have been among the top 20 R&D spenders every year since 2005.

RANK		Company	R&D spending		
2018	2017		2018 US\$ Billions	% of Revenue	Change from 2017
1	1	Amazon	\$22.6	12.7%	40.6%
2	2	Alphabet	\$16.2	14.6%	16.3%
3	5	Volkswagen	\$15.8	5.7%	14.1%
4	4	Samsung	\$15.3	6.8%	6.8%
5	3	Intel	\$13.1	20.9%	2.8%
6	6	Microsoft	\$12.3	13.7%	-5.7%
7	9	Apple	\$11.6	5.1%	15.3%
8	7	Roche Holding	\$10.8	18.9%	-8.7%
9	12	Johnson & Johnson	\$10.6	13.8%	16.0%
10	8	Merck	\$10.2	25.4%	0.8%
11	11	Toyota	\$10.0	3.9%	2.6%
12	10	Novartis	\$8.5	17.0%	-11.1%
13	15	Ford	\$8.0	5.1%	9.6%
14	20	Facebook	\$7.8	19.1%	31.0%
15	14	Pfizer	\$7.7	14.6%	-2.7%
16	13	General Motors	\$7.3	5.0%	-9.9%
17	16	Daimler	\$7.1	3.6%	-9.2%
18	19	Honda	\$7.1	5.4%	8.7%
19	24	Sanofi	\$6.6	15.1%	5.8%
20	23	Siemens	\$6.1	6.2%	4.9%
TOP 20 TOTAL			\$214.5	11.6%	7.3%

Note: Sums may not equal totals shown due to rounding.

Source: Capital IQ data, Thomson Reuters Eikon data, Strategy& analysis

FEDERAL R&D SPENDING

Table I. Federal Research and Development Funding by Agency, FY2016-FY2018

(Please note definitional difference in FY2016 and FY2018 data as described in the table notes)
(budget authority, dollar amounts in millions)

Department/Agency	FY2016 Actual	FY2018 Request	Change, FY2016-FY2018	
			Dollar	Percent
Department of Defense	\$71,421	\$53,396	n/a	n/a
<i>Department of Defense (adjusted)</i>		\$84,432	\$13,011	18.2
Dept. of Health and Human Services	32,243	26,144	-6,099	-18.9
Department of Energy	15,217	13,408	-1,809	-11.9
NASA	13,253	10,327	n/a	n/a
<i>NASA (adjusted)</i>		12,838	-415	-3.1
National Science Foundation	6,010	5,371	-639	-10.6
Department of Agriculture	2,657	1,991	-666	-25.1
Department of Commerce	1,681	1,567	-114	-6.8
Department of Veterans Affairs	1,222	1,357	135	11.0
Department of Transportation	927	923	-4	-0.4
Department of the Interior	973	818	-155	-15.9
Department of Homeland Security	582	564	-18	-3.1
Environmental Protection Agency	516	277	-239	-46.3
Other	1,600	1,554	-46	-2.9
Total	\$148,302	\$117,697	n/a	n/a
Total (adjusted)	\$148,302	\$151,244	\$2,942	2.0

Source: CRS analysis of data from Executive Office of the President (EOP), Office of Management and Budget, *Analytical Perspectives, Budget of the United States Government, Fiscal Year 2018*, May 23, 2017, pp. 203-205, https://www.whitehouse.gov/omb/budget/Analytical_Perspectives.

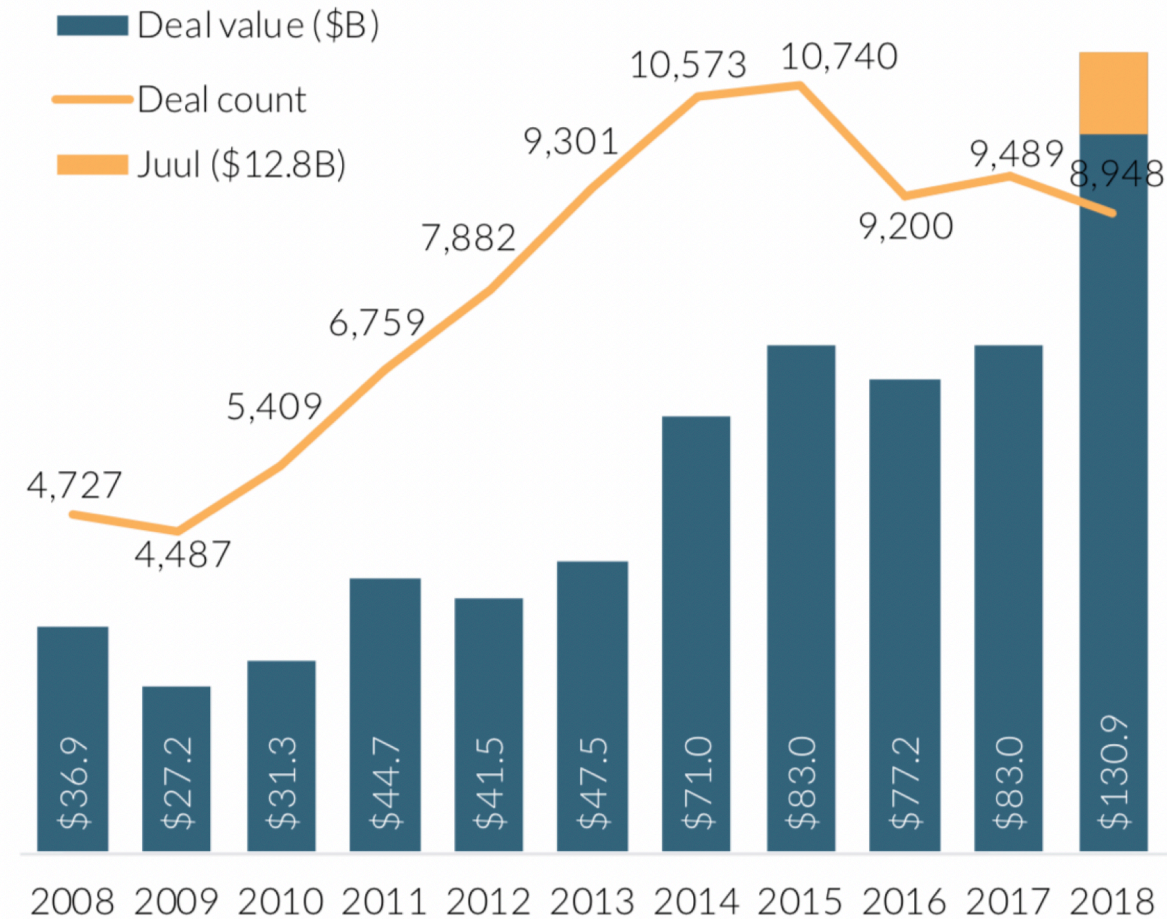
⁵ DOD R&D would be \$31.036 billion higher for FY2018 using the FY2016 definition of R&D than reported by OMB for FY2018 using the new definition. Email correspondence from OMB to CRS on May 26, 2017.

⁶ NASA R&D would be \$2.511 billion higher for FY2018 using the FY2016 definition of R&D than reported by OMB for FY2018 using the new definition. Email correspondence from OMB to CRS on May 26, 2017.

VENTURE FINANCING

Capital investment into US VC reaches new all-time high

US VC deal activity

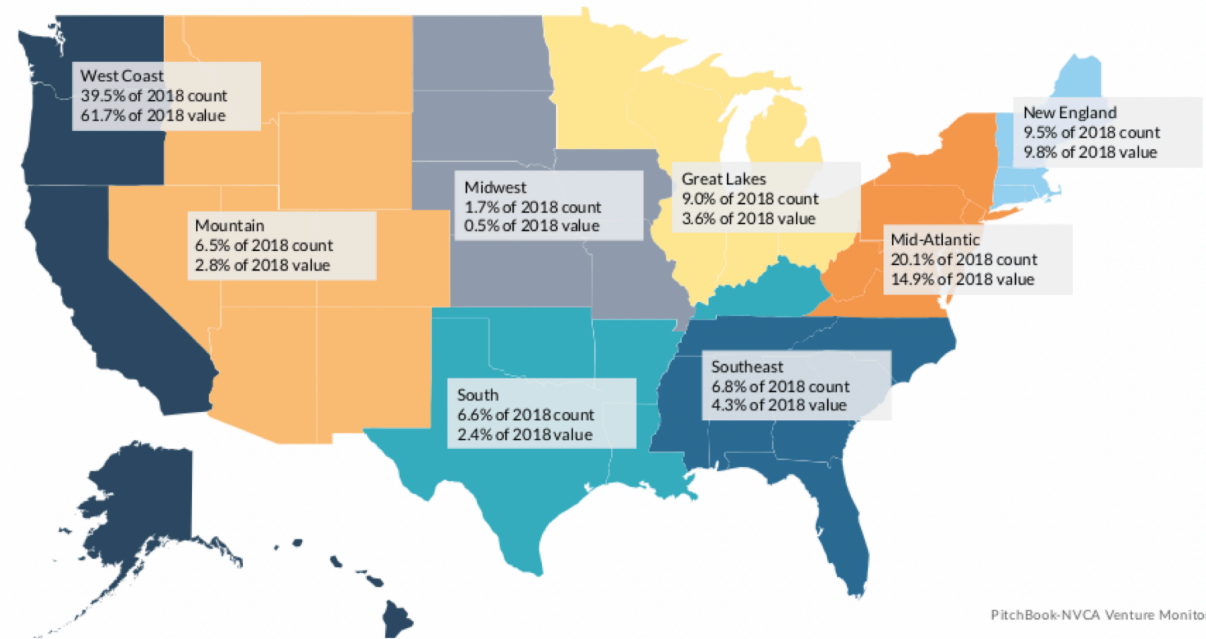


PitchBook-NVCA Venture Monitor

Activity by region

VC hubs outside Silicon Valley see greater proportion of VC

US VC deals by region (2018 total)



PitchBook-NVCA Venture Monitor

HERD COMPARISONS

Overall		Source of Funds			Research Area			
Ranking	Overall	NASA	DOD	Business	Computer Sci	Life Sci	Physical Sci	Engineering
#1	JHU	JHU	JHU	Duke	JHU	UCSF	Cal Tech	JHU
#2	Michigan	Colorado	Georgia Tech	MIT	CMU	U Penn	Michigan State	Georgia Tech
#3	UCSF	Maryland	Penn St	Ohio St	Georgia Tech	JHU	JHU	MIT
#4	U Penn	Cal Tech	Uni Svc Health	U Penn	USC	Duke	UC-Berkley	Penn State
#5	U Washington	Arizona	Texas	Texas/MDA	Illinois	U Washington	MIT	SUNY
#6	U Wisconsin	MIT	MIT	SUNY	Texas	Michigan	Arizona	Texas AM
#7	UCSD	UC-Berkley	UCSD	Stanford	MIT	Texas/MDA	Cornell	Michigan
#8	Duke	Arizona St	Washington	UCSF	Maryland	North Carolina	Maryland	Texas
#9	Harvard	Michigan	USC	JHU	Penn State	Yale	Stanford	Purdue
#10	Stanford	UCLA	Stanford	Michigan	Virginia Tech	Pittsburgh	Rochester	Virginia Tech
PURDUE	#37	#41	#26	#26	#21	#64	#39	#9

Source:
<https://www.nsf.gov/statistics/srvyherd/>

BD OBJECTIVES – CORPORATE

Become
Premier Research
University

- Achieve top 10 ranking for corporate and national defense sponsored research
- Establish leadership in defense, ag/food, mobility, life sciences, and digital convergence
- Advance land grant mission to make an impact in Indiana (and beyond)

Leverage
Destination to
Advance Innovation

- Become "home" to 25+ companies and external stakeholders
- Curate DP/DPD/WHIN as "smart community" to advance innovation
- Work with IEDC/CICP to advance economic development of region

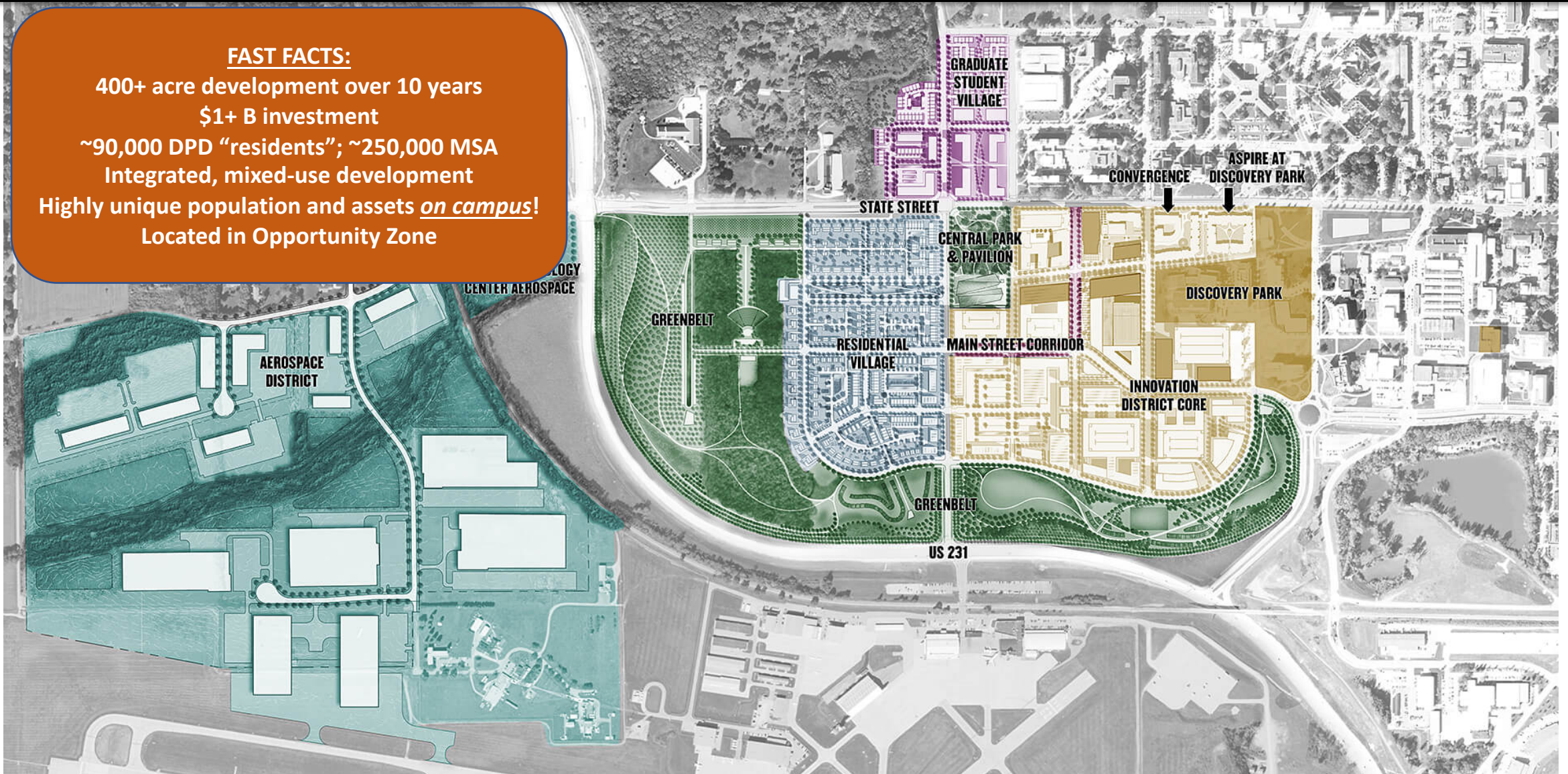
Become
Preferred Partner for
Collaboration and
Talent

- Become preferred partner among top innovators
- Create external mindset, proactive approach, and "win" as a team
- Develop programs that support talent acquisition and workforce development

"DESTINATION" PLACEMAKING IN DISCOVERY PARK DISTRICT

FAST FACTS:

- 400+ acre development over 10 years
- \$1+ B investment
- ~90,000 DPD "residents"; ~250,000 MSA
- Integrated, mixed-use development
- Highly unique population and assets on campus!
- Located in Opportunity Zone





The Convergence Center for Innovation and Collaboration

"LIVING LEARNING LAB" FOR RAPID INNOVATION EVALUATION

Innovation
and entrepre-
neurship

"Smart"
building and
community

Digital
Connectivity

Utilities and
infrastructure

Discovery Park District "Living Learning Lab" Advisory Board

David Broecker – Chief Innovation and Collaboration Officer
James Braun – Herrick Professor; Director Center HP Buildings
Darcy Bullock – Lyles Professor; Director Joint Transportation Program
Robert Cox – Assc. Dean Globalization; Head Construction Management
Karthik Kannan – Howatt Professor; BAIC Center – Krannert School
Jim Krogmeier – Professor, Assc. Head Electrical & Computer Engineering
Sorin Matei – Professor CLA; Director *Data Story Telling Network*
Dave McKinnis – Office Corporate Global Partnerships
Sunil Prabhakar – Director Integrated Data Science Initiative
Ali Shakouri – Kirk Professor; Director Birck Nanocenter

Mobility as a
Service



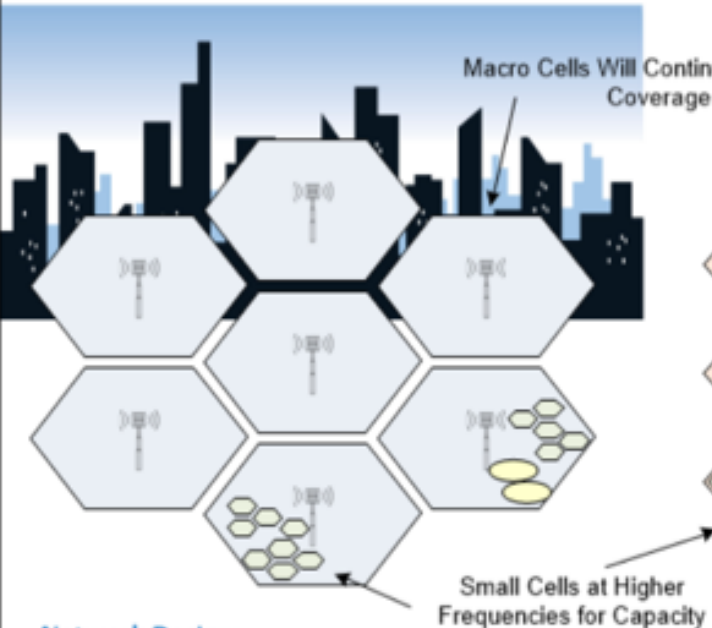
"LIVING LEARNING LAB" ACTIVITIES TRACKER

Focus Area	Activity	Who	Comments
Mobility	Mobility	Peak (ESN)/Cline/Bullock	Mass transit - Cummins
	Autonomous	Parks (WHIN)/Broecker	Rural test beds - RTO
Energy/Infrastructure	Energy Grid to support mobility	Gallagher	Phase 2 of mobility
	Energy Grid to support building	O'Hara (ESN)/Ziviani/Broecker	Solar/DC grid - Duke
Technology/Connectivity	5G Environment and Test Lab	Hendrix/Love/Roberts (IEDC)	Co-investment model
	DPD Data Strategy	Broecker/Sunil/Karthik	Part of Technology Roadmap
Smart Building/Community Life	District Hall/Front Porch	Michael	See project plan
	Art integration	Matei	Part of gallery strategy
Innovation/Entrepreneurship	Opportunity Zone	Edleman/Broecker	Published article
	Purdue "Portal"	Broecker/Mayar	Convergence service model
Governance/Strategy	DPD Learning Lab Advisory Board	All	Quarterly Meetings
	2050 Conference	Shakouri	Fall - 2019

FUTURE "5G" NETWORK DESIGN WILL BE DRAMATICALLY DIFFERENT

Wireless Network of the Present

*Insufficient Spectrum
Capacity Constrained
Competitive Alternative to Wireline for Some*

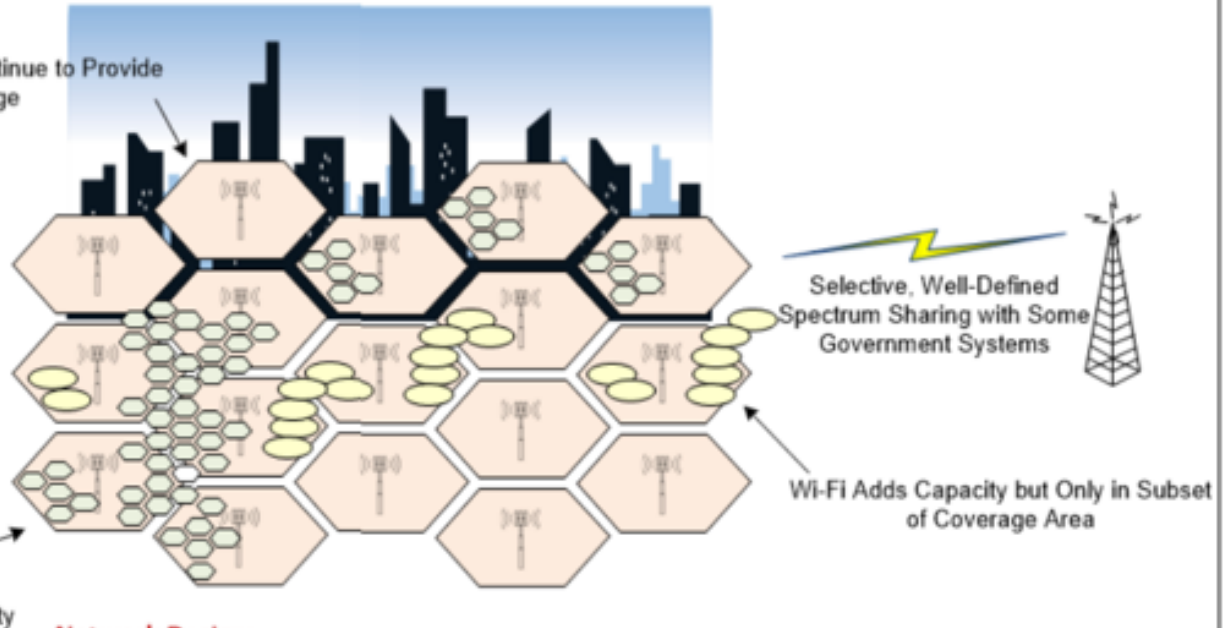


Network Design:

- Larger cells on average
- Some small cells
- Some advanced radio methods
- Wi-Fi and cellular mostly operate independently
- Limited sharing of spectrum with government
- Frequencies: current cellular (600 MHz to 2.5 GHz)
- Total spectrum used: approximately 1 GHz

Wireless Network of the Future

*Balanced Portfolio of Licensed and Unlicensed Spectrum
Significantly Greater Capacity
Competitive Alternative to Wireline for Many*



Network Design:

- Smaller cells on average
- Many small cells
- Many advanced radio methods (smart antennas, etc.)
- Unlicensed- and licensed-spectrum technologies work together in integrated network
- Selective sharing of spectrum with government
- Frequencies: current cellular bands and higher frequencies, including mmWave
- Total spectrum used: many GHz

DPD TECHNOLOGY ROADMAP ENABLING “DIGITAL CONNECTIVITY”

DPD
“Connected
Communities”
research
platform

Applications (i.e. faculty, students, commercial partners)

Curated “Big” Data Sets and Data Storage

Open-source,
high-capacity
technology
and business
platform

Integrated Platform Manager

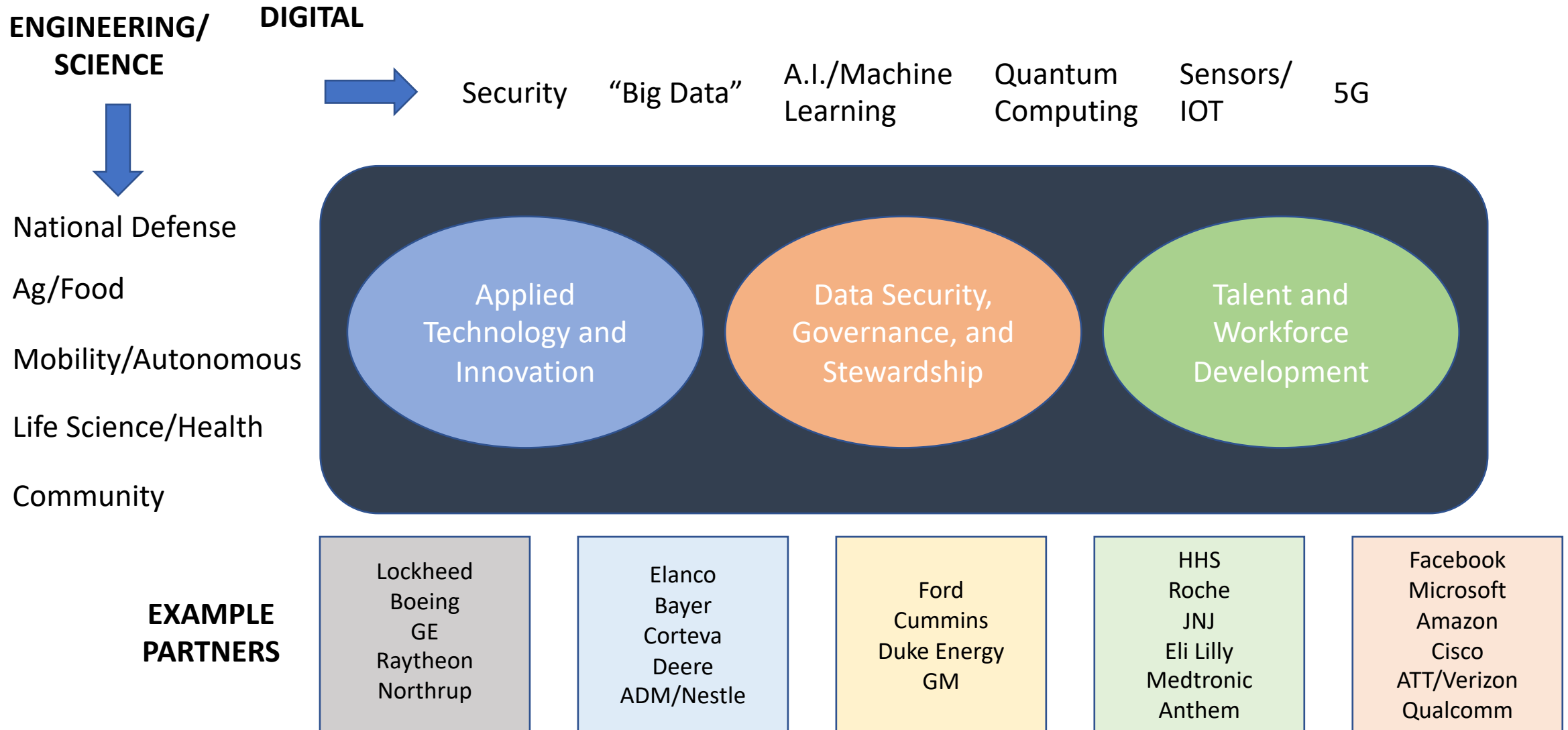
Broadband Spectrum (CBRS, ATT, Verizon, T-Mobile)

Sensors and IoT

Network/Switches/Furniture (wireless, wi-fi, 5G, etc.)

Infrastructure (fiber, wireless fiber – millimeter wave)

STRATEGIC ENGAGEMENT AROUND “INNOVATIVE CONVERGENCE”



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- Early engagement with and access to students
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